What do we mean by the intrinsic value and integrity of plants and animals?

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'Value' is among our most generic positive predicates, rather like 'good'. 'Integrity' is similarly both open and comprehensive. We will not be surprised if both ideas resist precision. Perhaps we need a caution that some of our most treasured goals are so inclusive as to resist simple definition, as with what it means to be 'true' or 'right' or 'free' or even 'alive'. Analysis helps bring clarity, but only when it improves our seeing a gestalt. The overarching gestalt ('truth') is that it is 'right' to respect 'life'. Such respect is ancient in religious experience; such respect is contemporary in conservation biology—a movement within biology as remarkable as is molecular or evolutionary biology.

Philosophers are cautious about moving from fact to value; that *x* is alive does not imply that *x* is good. But it is difficult not to draw the conclusion that life on Earth, a given, is also a good thing. One ought to respect life. Ethics has to fit that inclusive, generic duty into the particular, specific details. One approach is to ask where such life has intrinsic value, where it has integrity. When genotype develops into phenotype, presumptively at least each species, instantiated in individuals, is a worthwhile biological achievement and an adapted fit in its niche. Each is a distributed increment of life on Earth, instancing the richness of life collectively on this marvelous planet.

1. Organismic integrity and intrinsic value

I will be provocative, right from the start. Organisms are normative systems. A plant is a spontaneous life system, self-maintaining with a controlling program (though with no controlling center, no brain). It executes this project, checking against performance in the world. It composes and recomposes itself, maintaining order against disordering tendencies. Plants do not, of course, have ends-in-view. They are not subjects of a life, as with the higher animals to which we come. In that familiar sense, they do not have goals. Yet each plant develops and defends a botanical identity, an end-in-itself, posting a boundary between itself and the environment it inhabits. An acorn becomes an oak; the oak stands on its own.

This botanical program is coded in the DNA, informational core molecules, without which the plant would collapse into the humus. The genetic set distinguishes between what is and what *ought to be*. This does not mean that plants are moral systems. But the organism is an evaluative system, selecting resources for itself. An inert rock exists on its own, making no assertions over the environment. But the plant, though on its own, must claim the environment as source and sink, from which to abstract energy and materials and into which to excrete them. Plants thus arise out of earthen sources (as do rocks) and turn back on their sources to make resources out of them (unlike rocks).

The plant grows, reproduces, repairs its wounds, and resists death. All this, from one perspective, is just biochemistry—the whir and buzz of organic molecules, enzymes, proteins. But from an equally valid—and objective—perspective, the morphology and metabolism that the organism projects is a valued state. The organism is integrated; the parts co-act. Each of the parts is formed in the way that it is because it is informed about the integrity of the whole. *Vital* is a more ample word now than *biological*. The integrated life is spontaneously defended for what it is itself, without necessary further contributory reference, although (as we will notice) in ecosystems such lives necessarily do have further reference.

The plants don't care, so why should I? Nothing 'matters' to a tree; a plant is without minimally sentient awareness. By contrast, things do matter to the animals. True, things do not matter *to* trees; still, a great deal matters *for* them. We ask, of a failing tree: What's the matter *with* that tree? If it is lacking sunshine and soil nutrients, and we arrange for these, we say: The tree is benefiting from them; and *benefit* is—everywhere else we encounter it—*a* value word. Plants do 'care'—using botanical standards, the only form of caring available to them. The plant life per se is defended—an intrinsic value.

A plant is not an experiencing subject, but neither is it an inanimate object, like a stone. Nor is it a geomorphological process, like a river. Plants are quite alive. Plants, like all other organisms, are self-actualizing. Plants are unified entities of the botanical though not of the zoological kind, that is, they are not unitary organisms highly integrated with centered neural control, but they are modular organisms, with a meristem that can repeatedly and indefinitely produce new vegetative modules, additional stem nodes and leaves when there is available space and resources, as well as new reproductive modules, fruits and seeds.

Value is a matter of choosing preferences. So—the usual argument goes—plants cannot be valuers, because they do not have any options; they are just automatic biochemistries. But if we attach value to objective life defended—rather than subjectively attaching it only to human preferences—a plant defends a good-of-its-kind; it defends its life and kind as good-in-itself. To object that there is no value present because this norm is controlled by the genome and not selected by a conscious brain is something like objecting, on similar grounds, that there is neither information nor life in the plant.

To put this in the language of conservation biology, a plant is already engaged in the biological conservation of its identity and kind, long before conservation biologists come on the scene. What conservation biologists ought to do is respect plants for what they are in themselves—projects in conservation biology. That aligns human ethics with objective biology.

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2. Animal integrity/value

In higher animal life, unlike vegetable life, there is somebody there behind the fur and feathers. They have eyes, They call. The animal life, with its centered experience, is organic form in locomotion, on the loose, indifferent to if not desiring to avoid persons. The animal cares not to come near, sit still, stay long, or please. It performs best at dawn, or twilight, or in the dark. Yet just that wild autonomy moves us with a conviction of escalating value and integrity. I catch the animal excitement. Here is prolife motion, and for it I gain an admiring respect.

Plants are rooted to the spot, and they too move themselves in autotrophic metabolism, slowly, invisibly to my eye. But the animal must eat and not be eaten; its heterotrophic metabolism forces a never-ceasing hunt through the environment, an ever-alert hiding from its predators. If, as a carnivore, one's food moves as well as oneself, so much the more excitement. This requires sometimes stealth and sometimes speed. Unlike plants, the animal resources, though within its habitat, are at a distance and must be sought. That is the survival game, with all animal motions close-coupled to it.

The pines and oaks are *objects;* they live without sentience; but the squirrels and the antelope are *subjects*. When experiencing an item in the flora I see an 'it'. But with the fauna, especially the vertebrate, brained fauna, I meet a 'thou'. I see them; they also see me. I eavesdrop; they may flee. One may spook a bighorn, but one cannot spook a columbine, and so the sense of integrity differs because of the reciprocity. There is a 'window' into which we can look and from which someone looks out. They have, so to speak, points of view. There is fire in those eyes.

The critic will say that my searching for integrity in wild lives overlooks as much as I see. The bison are shaggy, shedding, and dirty. The marmot is diseased and scarred. The elk look like the tag end of a rough winter. Every wild life is marred by the rips and tears of time and eventually destroyed by them. Yes, and we must couple genetics and evolutionary ecology. The integrity sought, the value defended is an ideal toward which a wild life is striving. In the language of the geneticists, the integrity lies in that phenotype producable by the normal genotype in a congenial environment. Integrity includes this conflict and resolution in the concrete particular expression of an individual life.

3. Survival value and adapted fit

The core of Darwinian theory is survival value and adapted fit, as organisms occupy their niches. Adapted fit certainly suggests both that something is of value to the organism, namely, adapted fit, and also that the evolutionary process can and often does improve that value, namely increase adapted fit. Adapted fit can also be lost, which results in extinction. Evidently, this sort of value is not anthropocentric, since organisms survived on the basis of adaptive fit for billions of years before humans were even on the planet—and also, of course, they almost as often went extinct.

We sometimes say that science is value free; and this is correct if we mean that science is descriptive, not prescriptive. There is no scientific guidance of human life, and hence the caution about moving from *is* to *ought.* But in other senses, biology is not value free at all; to the contrary, its central theory, natural selection, is built on 'survival value'. Biologists regularly speak of the 'selective value' or 'adaptive value' of genetic variations. Plant activities have 'survival value', such as the seeds they disperse or the thorns they make.

Natural selection picks out whatever traits an organism has that are valuable to it, relative to its survival. When natural selection has been at work gathering these traits into an organism, that organism is able to value on the basis of those traits. It is a valuing organism, even if the organism is not a sentient valuer, much less a vertebrate, much less a human evaluator. And those traits, though picked out by natural section, are innate in the organism, intrinsic to it, if also valuable relative to the niche in which the organism is an adaptive fit. It is difficult to dissociate the idea of value from natural selection. Value generated and conserved is the first fact of evolutionary natural history, and the result has been the richness of biodiversity and complexity on Earth, going from zero to five or ten million species, and passing through several billion species en route.

4. Integrity/value in historical species lines

Organisms exist in dynamic species lines, persisting over millions of years, overleaping short-lived individuals. Species exist only instantiated in individuals, yet are as real as individual plants or animals. The claim that there are specific forms of life historically maintained in their environments over time seems as certain as anything else we believe about the empirical world. Organismic integrity, conserved in the individual, is dynamic and flexible over species lines. Integrity is constantly re-evolving. Speciation is sometimes in progress, yet species are evolutionary lines with identity in time as well as space.

Processes of value that we earlier found in organic individuals reappear at the specific level: defending a particular form of life, pursuing a pathway through the world, resisting death (extinction), regeneration maintaining a normative identity over time, creative resilience discovering survival skills. Even a species defends itself; that is one way to interpret reproduction. Life is something passing through the individual as much as something it possesses on its own. The individual represents (re-presents) a species in each new generation. It is a token of a type, and the type is more important than the token. It is as logical to say that the individual is the species' way of propagating itself as to say that the embryo or egg is the individual's way of propagating itself. The dignity resides in the dynamic form; the individual inherits this, exemplifies it, and passes it on.

If, at the species level, these processes are just as evident, or even more so, what prevents integrity being present at that level? The appropriate survival unit is the appropriate level of evaluation and moral concern. The individual is subordinate to the species, not the other way around. The genetic set, in which is coded the *telos*, is as evidently the property of the species as of the individual through which it passes. A consideration of species strains any ethic fixed on individual organisms, much less any ethic fixed on sentience or persons. But the result can be biologically sounder.

This does not mean that a species has a controlling center, any more than a plant has a brain; but both the organism and the species are survival processes. A species has no self. It is not a bounded singular. There is no analogue to the nervous hookups or circulatory flows that characterize the organism. But singularity, centeredness, selfhood, individuality, are not the only processes to which integrity and value attach. Identity need not attach solely to the centered organism; it can persist as a discrete pattern over time. The plant resists death; the species resists extinction. At both levels, botanical identity is conserved over time.

Any sentiogenic, psychogenic, vertebragenic, or anthropogenic theory of value has got to argue away all such natural selection as not dealing with 'real' value at all, but mere function. Those arguments are, in the end, more likely to be stipulations than real arguments. If you stipulate that valuing must be felt valuing, that there must be some subject of a life, then trees are not able to value, their leaves and thorns are no good to them, nor might more efficient leaves or sharper thorns be any good to the species of which they are members, and that is so by your definition. But we wish to examine whether that definition, faced with the facts of biology, is plausible.

5. Captured integrity/value

The world is a field of the contest of values. An ecosystem is a perpetual contest of goods in dialectic and exchange, propelled by value capture and transformation. The organismic integrity defends a self but it is not a self-contained; the organism incessantly moves through its environment, ingesting and eliminating it. Organismic goods are sacrificed for the goods of others. The competing, exchanging, and intermeshing of goods in an ecosystem means that the goods of organisms are contextually situated. The value first concentrated in individuals now fans out from the individual to its role and matrix. Integrity, skin-in, needs integration, skin-out.

One can admire flight in a peregrine falcon, or the gait of a cheetah; but locomotion takes high-energy funding. Muscles, nerves, and brains depend, several trophic rungs down the pyramid, on plants (99.9% of the biomass) that soak up the sunlight. By their concentration on capturing solar energy, stationary plants make possible the concentrated unity of the zoological world. All heterotrophs of spectacular evolutionary achievement live in utter dependence on plants. The system is a value transformer that interlocks dispersed achievements. Falcons feed on warblers, which feed on insects, which feed on plants. It is the protein and lipids in warblers that falcons can use, that in insects that warblers can use; the energy that plants have fixed is recycled by insects.

Disvalue to the prey is value to the predator, and, with systemic integration, perspectives change. The death of the hunted means life to the hunter. Nutrient materials and energy flow from one life stream to another, with selective pressures to be efficient about the transfer. The pains of the prey are matched by the pleasures of the predator. And more, novel biological achievements result from predation. Autotrophs synthesize their own food; heterotrophs eat something else. Could we have had a world with only flora, no fauna? Possibly not, since in a world in which things are assembled something has to disassemble them for recycling. In any case, no one thinks that a mere floral world would be of more value than a world with fauna also.

In a floral world, there would be no one to think. Heterotrophs must be built on autotrophs, and no autotrophs are sentient or cerebral. Brains, like muscles, take high-energy funding. Could there have been only plant-eating fauna, only grazers, no predators? Possibly, though probably there never was such a world, since predation preceded photosynthesis. Even grazers are predators of a kind, though what they eat does not suffer. Again, an Earth with only herbivores and no omnivores or carnivores would be impoverished. The animal skills demanded would be only a fraction of those that have resulted in actual zoology—no horns, no fleet-footed predators or prey, no fine-tuned eyesight and hearing, no quick neural capacity, no advanced brains.

Nor are all benefits to the predators. The individual prey, eaten, loses all; but the species may gain as the population is regulated, as selection for better skills at avoiding predation takes place. The prey not less than the predator will gain in sentience, mobility, cognitive and perceptual powers. Being eaten is not always a bad thing, even from the perspective of the prey species. The predator depends on a continuing prey population; they have entwined destinies.

The kills are the capture of skills. Upper level organisms use others' vital products, organic resources that they cannot produce themselves. The integrity in individuals is an equilibrating of values in the system of life. Predation is a value shunting device. Feeding is part of a feedback loop, and by such value capture all the higher values (sentience, locomotion, mentality, conditioned behavior, learning) depend on the value support in the lower rungs of the pyramid (photosynthesis, decomposition). Organisms inherit value not only in their genes but from their competitors, enemies, and prey. There is a food chain from cheetah through gazelle to Bermuda grass. The system is a web where loci of intrinsic value are meshed into a network of instrumental value; and in this system the on-going defense of valued life generates new achievements in biodiversity and complexity.

The context of creativity logically and empirically requires this context of conflict and resolution. An environment entirely hostile would slay us; life could never have appeared within it. An environment entirely irenic would stagnate us; advanced life, including human life, could never have appeared there either. Oppositional nature is the first half of the truth; the second is that none of life's heroic quality is possible without this dialectical stress. Take away the friction, and would the structures stand? Would they move? Muscles, teeth, eyes, ears, noses, fins, legs, wings, scales, hair, hands, brains—all these and almost everything else comes out of the need to make a way through a world that mixes environmental resistance with environmental conductance. Half the integrity, half the beauty of life comes out of endurance through struggle.

6. Shared integrity/value

This value capture is value sharing; we can shift gestalts to gain a new perspective. 'Capture' is a hostile word. This clash of values, with more sophisticated critical insight, is reframed as symbiosis. The struggle is the dark side of the flourishing, which lights up in rich biodiversity, manifest in communities. Integrity requires dependence as much as it does independence. Things do not have their separate natures merely in and for themselves, but they face outward and co-fit into broader natures. To dislike the interlocking value capture is something like looking at a jigsaw puzzle and complaining that the pieces are misshapen, unaware of how they fit together to form an integrated whole picture.

Value-in-itself is smeared out to become value-in-togetherness. Value seeps out into the system, and we lose our capacity to identify the individual as the sole locus of value. Intrinsic value, the value of an individual 'for what it is in itself ' becomes problematic in a holistic web. Every intrinsic value has leading and trailing 'ands' pointing to value from which it comes and toward which it moves. But everything is good in a role, in a whole. Individual 'integrity' has to be 'integrated' into the ecosystem in which the individual resides. Value has to be simultaneously distributed around and these distributed values integrated into a systemic whole. Each is for itself, but none is by itself; each is tested for optimal compliance in an intricately disciplined community. Every organism is an opportunist in the system, but without opportunity except in the ongoing system. Each is against the others, but each locus of value is tied into a corporation where values are preserved even as they are exchanged.

From that point of view, we see conversions of resources from one life stream to another—the anastomosing of life threads that weaves an ecosystem. Now it becomes difficult to say whether anything of value is lost at all; rather these pressures seem to insist on and to build integrity.

An organism must defend the integrity of its 'self, and hence the eating and capturing of value from others. Indeed, so central is this defense of self that some biologists claim that life is invariably self-centered, 'selfish'. Theoretical biologists have come to incorporate this organismic genetic 'selfishness' into what they call 'inclusive fitness'. Nothing is more obvious in biology than that animals often defend their own kin, because they 'share' genes with such kin. But thinking still more inclusively, one must ask how far genetic information is 'shared'.

I am again choosing words provocatively. 'Share' has the Old English and Germanic root, 'sker', to cut into parts, surviving in 'shears', 'plowshare', and 'shares' of stock. As used here, to 'share' is to distribute in parts the self's genetic information. Genes reproduce or communicate what survival value they possess; they share [= distribute in portions] their information, literally, although preconsciously and premorally. The central feature of genes is that they can be copied and expressed, again and again. They replicate. Their power to send information through to the next generation is what counts. The genetic information gets allocated and reallocated, portioned out, and located in various places. Whatever the process, rather obviously genetic information has been widely distributed, communicated, networked, recycled, and shared throughout natural history.

Genes 'divide'. They 'divide' in order to 'multiply'. Life must be enclosed in cells; yet cell division is required for cell multiplication, for ongoing life. The cell division requires genetic division. 'Dividers' are required to partition out their goods and this multiplies such goods. Such division and distributing, replicating, recycling, together with adapted fitness, places each gene where it belongs, in a commons in which it participates. The gene is engaged in dispersing vital information, in transmitting its intrinsic values. Genes are a flow phenomenon. Genes must find a method of distributing and elaborating, of proliferating what values they contain and conserve. That process makes possible the genesis of life, the accumulation of all those values inherent in biodiversity and complexity.

Indeed, recalling the inclusive fit extended to inhabiting a niche, the survival of an organism depends as much on others in its community and on genes it does not own as on genes that it does. Plants depend on the carbon dioxide released by animals, who depend on the oxygen released by plants. An animal must eat the grass, or eat what has eaten the grass, and so the trophic pyramid builds up. Energy and materials cycle and recycle through the system. In this system, the only capacity that the individual organism has is to be 'self-interested', to defend its self and its kind; but the truth is that the system requires the organism to co-act, to operate within the dependencies, resources, and constraints of its situation, and in that sense to co-operate, to operate together with what else is around it.

In a drought, the survival of the lions may not depend so much on whether they are fleet of foot and with savage canines as it does on whether the Bermuda grass that the zebras eat can cope with the drought, perhaps by mutations that enable the grass better to capture nutrients released by fungal and microbial decomposers. In figuring out organismic integrity and intrinsic value, one needs all the levels from distribution and integration in genes to distribution and integration in ecosystems.

7. Culturing natural values

Continuing in culture, the value capture earlier characteristic of nature cannot *as such* be either unecological or wrong. We may and must eat, for instance; food chains are the webwork of ecosystems. Higher trophic levels always 'eat up' the lower ones. Going further, however, culture rebuilds nature and its products can be radically different

Jet planes powered by petroleum engines and petroleum differ from geese with wings powered by muscles and ATP (adenosine triphosphate).

When humans appear, in the only animal able to evaluate and choose from its lifestyle options in behavior, such value capture requires justification. Value gain in humans must be argued against value loss in the natural world. Now with an added moral dimension, we ought again to search for a gestalt in which values are distributed, shared, integrated, into a nature-culture synthesis. We have an obligation to argue a case for greater value achieved.

The reason for the newly appearing demand for justification is that the framework of value capture changes. Value capture in the wild, though it sacrifices individuals, remains in the context of co-evolution and increased adaptive fit. The skills of the prey are sharpened quite as much as those of the predator. Plants evolve complex defenses to regulate their grazers, manufacturing an array of sophisticated biochemistries. Even diseases and parasitism result in more elaborated and ingenious immune systems and bodily defenses in the host, co-evolving with more ingenuity in the pathogens (often invisible to us at the microscopic levels). The co-evolutionary race continues. The dialectic is creative.

This honing of increased integrity drops out when culture captures nature. Artificial selection is not natural selection. The organism is likely to be selected because it domesticates well, makes a good laboratory animal, responds to breeding pressures, is docile, and can be husbanded for the efficient and economical exploitation of the desired genetic results. None of these pressures are likely to increase the integrity or intrinsic value of the cultivar or livestock. Maize, for instance, once wild in Central America, has been bred so that the grains do not fall from the ear, which suits the people that eat corn, but means that maize can no longer propagate itself in the wild.

John Muir contrasts wild sheep, which he admires, "elegant and graceful as a deer, every movement manifesting admirable strength and character", with the domestic ones, which he despises, stupid "expressionless, like a dull bundle of something only half alive" ([1894] 1985, pp. 210-211). Indeed, it is difficult to envision any of the properties admired (the horns, the eyesight, the agility, the musculature, the wool) except as created in the arduous environment of natural selection. After a hunt on Mount Shasta, Muir examined closely the carcasses of a dead ram and ewe, and, repentant and chagrined by his kill, shouted, "Well done for wildness!" ([1875] 1980, p. 229). If the standard of evaluation is our human subjective preferences, fashions in wool, the domesticated breeds can be better; but objectively, in natural systems, the wild sheep, honed to its strength, alertness, and endurance by the struggle for survival, has more integrity by an order of magnitude.

The domesticated is the degraded. No barnyard turkey has the alertness of a wild gobbler. Make a pet of an animal and you degrade it, because you modify its behavior to decorate your culture, as with a French poodle. Perhaps you increase some skill, as speed with a racehorse or strength with a mule. Sheep dogs may have developed skills similar to natural ones. Dogs for the blind are highly trained, but live quite constrained lives. But in all these cases breeders and trainers simultaneously sacrifice autonomy and adapted fit. They are allowed to reproduce only at our convenience. The hybrids we produce may be sterile, as are mules. Or their progeny may be eliminated, as with steers.

The increasingly artifacted organism is likely to have increasingly reduced capacities, either by design or as an accompaniment to other increased capacities for which we are selecting—as with plump-breasted but nearly wingless chickens, or pigs engineered with dulled sensitivities so that they are less frustrated in their small pens.

That an organism has been genetically modified does not *ipso facto* mean that its integrity has been compromised. The modified plant or animal might be a better adapted fit than it was before. Species in the wild reach local adaptive peaks, but not necessarily optimal ones, and some transgenic modification might relocate a species on a higher adaptive peak. There is always the possibility that exactly what one wild species needs for still better adapted fit has been discovered in another line, too distant from it for transfer by any natural genetic processes such as sexuality, hybridization, or jumping genes. A benevolent geneticist might effect such a transfer; and that would leave us wondering whether the benefited species had lost or gained autonomy.

Recently, transgenic corn plants now contain a bacterial gene that produces an insecticidal protein rendering them poisonous to earworms. The ancient genetic alteration keeping grains in the ear compromises the integrity of the plant more than this recent one, if indeed the latter does at all. If we could genetically engineer the American chestnut against the introduced fungus that has destroyed it, I would readily approve.

Such cases will be rare. Transgenics will regularly have reduced adapted fit, which is to say, reduced integrity. Indeed, when we move from traditional breeding to transgenic species, we want to assure that transgenics cannot survive on their own, lest they get loose in the environment. That transgenics just might become weedy adapted fits either in themselves or by genes that transpose to nearby wild relatives is considered a major danger in genetic engineering. We may simultaneously engineer in the gene whose products we want and some terminator gene to make sure that the organism does not reproduce unless we facilitate the reproduction. So we must cripple them to make them safely serviceable to us.

The burden of proof increases on those who wish to compromise the original integrity to show that greater value is promised by the intrusion. Value and integrity are often destroyed in wild nature; but there is a presumption of replacement by species that are better competitors because they have an edge over those they replace. But there is no such presumption with artificial breeding.

Using an organism instrumentally does not preclude respecting it intrinsically, for there will always remain some hybridizing of the original integrity with the introduced modification for human use. So far as that integrity remains, it constrains our uses of the organism. The question to ask is: How far has the quality of life of the organism been reduced? Have the original survival skills become abnormal, stunted crippled? Have we eliminated the more sophisticated qualities of the animal, dulled it down, de-sensitized it? Maybe the transgenic sheep are only making the desired drug in their milk and are otherwise not much different. But the pigs with human growth hormone have arthritis, walk with difficulty, and suffer high levels of stress.

Critics sometimes object to genetic manipulation because it is 'unnatural'. 'Unnatural' is a dangerous normative term. Most of our cultural activities, such as attending ethics conferences, are unnatural in the sense that they are not found in wild spontaneous nature. Diseases are natural; we seek to heal diseases. Health too may be natural, but medically manipulated pharmaceuticals are cultural artifacts. Whether we can object to an activity as being unnatural is case specific. Sometimes yes, sometimes no, the determining norms may come from culture not nature.

Still, there is truth in the worry that increasing genetic manipulation, recently escalated with transgenic capacities, is increasingly unnatural. That is, such manipulation is more and more likely further to remove the animal from its original characteristics, which once did evolve and result in that species' characteristic integrity and intrinsic value. A shorthand way of phrasing this is that genetic engineering goes 'against their nature', so far as any such 'nature' is still left in them.

Compared to the natural processes, transgenic manipulation is violent (so to speak) with its manipulated chop up and re-shuffle, throwing the genetic recombination processes on the edge of chaos. When gene x of species A is implanted in the gene y of species B, there results a jumble of the cutting and splicing, the error-correcting, so that the enzymes that are triggered try to do what they have never been called on to do before. The process is likely to be highly artificial, and therefore abortive, since this genetic innovation has not taken place through anything resembling natural mating and recombination. Most of the manipulated material is so adulterated that it has to be discarded; one hopes that a few of the adulterations just might prove to be both viable and useful for human purposes.

Although it is likely to be so, we cannot say that the transgenic process is unnatural, more unnatural than traditional plant breeding, and end the argument there. Even in wild nature, as geneticists are now learning, there are transposable genetic elements, jumping genes, reticulations in cladistic lines. We humans share most of our genes with animals, indeed many with plants. Nor can we complain about mutants and reshuffling, with the inevitable discards, for this too is characteristic of nature. But the tinkering in nature is in search of better adaptive fit; the tinkering in genetic engineering is in search of more profits. The nearer a domesticated plant or animal is to the wild type, the more likely crossing species barriers is to violate the integrity of that plant or animal.

My conclusion is that in culture we may use, alter, engineer, transform the values found in nature, but not without respect for those values. We must argue the case for an increase of value traded against the conservation of integrity. Perhaps we need something like an account of reparations: the more we sacrifice integrity by engineering for our human purposes, the more obligation we simultaneously incur to see that such integrity elsewhere remains in the wild on this marvelous planet

The genetic processes in nature are a remarkable problem-solving process, generating trial-and-error solutions, conserving the better adapted fits, and resulting in the wealth of biodiversity on Earth. Geneticists adapting this process for cultural benefits, who are also generating by trial-and-error novel biological achievements, ought to come the better to appreciate the intrinsic value and integrity of the life that they take into their hands.

Muir, John, [1894] 1985. *The Mountains of California.* New York: Viking Penguin.

Muir, John, [1875] 1980. 'Wild Wool'. Pages 227-242 in *Wilderness Essays.* Salt Lake City, UT: Peregrine Smith.

Discussion following Holmes Rolston's paper

Donald Bruce asked what was better: the alertness of the wild turkey in a dangerous situation in the wild or the relative dullness of the domestic species in a much safer situation. If the domestic animal is more secure, is this necessarily a degradation?

Holmes Rolston replied that it is a degradation because, although they are more secure, they have less autonomy and alertness and are unable to care and cope. They are like pets such as French poodles with painted toenails. Although barnyard turkeys are better than battery turkeys they have lost a great deal of their wild integrity. They are not autonomous. They are not on their own. If you are walking through the woods and you think you might have seen a turkey, if you discover that it's a barnyard turkey you just stroll on by; if you discover that it's a wild turkey, you have had a good day.

Referring to the comment that genetic engineers might be able to move an organism to a higher adaptive peak, Henk Verhoog pointed out that the tendency at the moment is for GM organisms to be protected from their environment because they are very often not adapted to it

Rolston agreed and said that we usually do not want GMOs to be adapted to the environment. Ninety-nine times out of a hundred the transgenicist will give an organism less integrity. If it has too much he might put in a terminator gene. But it would be possible for a conservation biologist who is a transgenicist, perhaps to enable an organism to survive in the wild when it wouldn't otherwise. Here Rolston returned to the example of the American chestnut which has a blight which has been destroying it for some 75 years. But some plants persist, they will grow until they get fissured bark and then the fungus gets in and destroys them. He would approve of finding a way through transgenics of putting genes from the Chinese chestnut, which is resistant, into the American chestnut in order to reintroduce it to the landscape. Biologists say that organisms can be on local adaptive peaks. A species might be on one peak, but it cannot get to another because it would have to go down and then up again. But another species on the adaptive peak it wants to reach might have a gene which, if transferred by genetic engineering, could enable the transgenic species to get from one adaptive peak to the other. Genetic engineering might therefore have some uses in conservation biology. For the most part that will not happen because it will be driven by profits and there will be fears that these organisms will get loose in the environment, so we would need protection measures.

Bruce Whitelaw suggested that it might be better to modify the fungus rather than the American chestnut. Rolston agreed that this option would certainly have to be considered by what he called restoration biology.

Judyth Sassoon turned the focus to viruses which even though they are not autonomous beings, evolve, fight for survival and are part of the whole genetic exchange flow. What right has the World Health Organisation to campaign to vaccinate and eliminate a species from the environment?

Margaret Colquhoun asked if genetic engineering were to be used in conservation biology, would the transgenicist not have to have an intimate knowledge of the genetics of the whole ecosystem.

Rolston agreed but added that he might risk it with more limited knowledge if he thought that the organism was becoming extinct. It would have to be case specific based on the arguments pro and con. One thing we might have deliberately eliminated from the environment is the smallpox virus, though it still exists in containment somewhere. He would be opposed to eliminating smallpox if it were widespread as part of ecosystems. But smallpox was mostly a human disease carried by humans which can be studied using armadillos and not much else. Where a disease is a human pathogen, he said that he might want to use different criteria, because it is not in the context of co-evolution and natural selection in the same way as, for instance the AIDS virus in green monkeys. We probably would not want to take it out of the wild. The same probably applies to malaria. We might want to fix it so that humans do not get malaria. Natures and Cultures are rather different. He would continue the co-evolutionary race in Nature, but does not think the co-evolutionary race is as relevant in Culture. Those two aspects come into the picture when deciding what to do with diseases. Some biologists say viruses are alive and some of them say they are not. He considers them to be marginally alive and would not wish to get rid of a harmless virus. It does not have autonomy therefore it does not seem to have a violable integrity. But account would have to be taken of viruses that are human pathogens. On the map of living versus non living things the virus is a borderline case. But the biological world is full of borderline cases regarding what is and is not alive.