Two

Illumination With Black Boxes

> Nothing can be at first sight more implausible than his theory, and yet after beginning by thinking it impossible one arrives at something like an actual belief in it.
>
> John Stuart Mill

I will use a "black box" to explain how cancer selection caused animal evolution.

A black box is a conceptual device employed in certain types of analytical thinking. It is simply a graphic metaphor for the presumption that certain activities occur as part of a process. The theorist doesn't claim precise knowledge of the mechanisms he's placing inside the black box, he merely presumes, based on logic, or observation, or both, that they work.

To cite a famous historical example, when Charles Darwin developed his theory of evolution he had no way of knowing the mechanics of inheritance, of how the variations he observed in individual organisms were passed to offspring. Gregor Mendel, the father of genetics, *did* manage to figure it out during Darwin's lifetime, but no one paid attention to that amateur scientist's experiments; Darwin never got the news. Knowing nothing about the rules of inheritance, he was forced to develop his theory of evolution with the mechanisms for precise inheritance inside a black

box.*

I use black boxes in a deliberate and literal fashion to demonstrate cancer selection's role in evolution. But before doing that I need to establish, in a black box sort of way, just what cancer is.

> Cancer is a morbid process that can begin in any animal cell that normally divides. It starts when a mutational event inside the cell transforms it to a state in which it and all its descendant cells are compelled to divide in a rapid, aggressive, and destructive manner. Unless the animal musters effective natural defenses** against those malignant cells, they relentlessly proliferate in an opportunistic, vegetative fashion until they kill the organism, usually by interfering with the function of a life-supporting organ.

I've already said that mutations played a significant role in evolution. However, those mutations occur in germ line reproduction, during the transfer of genetic material from parent organisms to the fertilized egg cell which becomes their offspring. The mutational events we are now considering--*somatic mutations*--are *replication errors* that occur during *mitosis*, when a cell divides and the genetic material is transferred to the two new cells.

Unlike mutations in the germ line, which occasionally enhanced the survivability of offspring, mistakes during mitosis could *never* benefit the lineage. Even in the event--a very unlikely one--that the somatic mutation increased the survival chances of the organism, it would be impossible for that benefit to be passed to its offspring. There is an impenetrable obstacle, called the Weismann barrier (after August Weismann, the nineteenth century theorist who first suggested that it exists) that prevents changes in somatic cells in individuals from affecting cells that produce the germ

---

* He didn't use that term. It's of twentieth century origin.

** Since I am developing a theory of how evolution worked over several hundreds of millions of years, possible medical intervention against cancer is not relevant.

line's transmitters--the sperm and egg cells, called, collectively, *gametes*. Twentieth century research has confirmed Weismann's idea. Reproductive cells--those that will produce the gametes that pass the DNA on to the next generation--are, in animals, sequestered from ordinary somatic cells very early in the animal's life. As a result, *all somatic mutations are evolutionarily useless*.*

The idea that cancer is initiated by a mutational event in a somatic cell is not new. Perhaps the first hint of that connection was uncovered in the nineteenth century when scientists discovered that X-rays could cause both mutations and cancer.** Discoveries in this century confirmed and strengthened that suspicion. One of the most significant was Bruce Ames' finding in the 1970s (which was foolishly ignored by the evolutionary biologists) that virtually *all* mutagens--the things that cause mutations--are also carcinogens. Further confirmation was obtained in the early 1980s when Robert A. Weinberg, a molecular biologist at Massachusetts Institute of Technology, identified a specific mutation that caused a human cell to become cancerous. But it was Ames' establishment of the correlation between carcinogenicity and mutagenicity that completes the constellation of factors I need to establish the black box relationships that will introduce my new theory of evolution.

My first black box represents a juvenile animal. This animal might be just a few days old and have only a few dozen body cells, or it might, if it were a preadult elephant, have already lived for a dozen years and consist of many trillions of cells. The precise age, appearance and species

---

* I am excluding from my definition of somatic mutations any mutations in somatic cells that have gametic offspring. Unlike animals, plants do not sequester cells that produce gametes from other somatic cells early in development; some germ line mutations in plants may begin as mutations in somatic cells. According to my definition somatic mutations are those passed exclusively to other somatic cells, never to gametes.

** Seven years after Wilhelm Roentgen discovered X-rays (in 1895) a worker at one of the first radiation laboratories died of cancer. He had been in the habit of testing new X-ray tubes by fluoroscoping his own hand. It was many years before the connection was made, and most of the first generation of radiologists died of cancer.

of the animal are not important. What *is*

important is that this imaginary animal is prereproductive, that it could not possibly as yet have any offspring.

I show the simple black box relationship between carcinogens and cancer in the illustration at the top of Figure One. If we were to place a sufficient quantity of a carcinogen into the black box (into our imaginary animal) the output would be cancer. That is a simple, straight-forward cause and effect relationship based on a self-evident truth: carcinogens cause cancer.

Since we know, from the Ames correlation, that carcinogens are mutagens, we can make an initial substitution on the input side of the black box. We can replace the word "Carcinogen" with the word "Mutagen" to describe the initiator of cancer.

Now let's move to the output side of the black box. Based on the presumption that most cancers are lethal, we can substitute, "Death of Juvenile" for "Cancer." Because the animal has not yet reproduced, any genetic material it carries for possible transmission to future generations will perish when it dies. Biologists call this extinction of genetic material "Genetic Death" and that is what, in the last substitution of this exercise, we will label the output from the black box. Our substitutions completed, what we have now is a black box showing the cause "Mutagen" and the effect "Genetic Death."

I will return to this black box later in the chapter. But at first I must set down one of the fundamental premises of my theory.

> *My theory asserts that there were cancer triggers or functional oncogenes in every somatic cell of every specimen of every animal species that ever existed.*

The postulated presence of oncogenes in every animal cell enables us to describe a simple black box scenario of what happens inside a cell when cancer begins. There is no need to diagram this process; I will simply list the steps:

1. A mutagen-carcinogen initiates a--

2. Mutational event, which triggers an--
3. Oncogene, which causes--
4. Transformation to the cancerous state.

(Cancer researchers, who focus on actual events inside the cells of modern animals, especially humans and other mammals, will find my description of the mechanism that triggers cancer much too simple. They might point out, for example, that some human cancers do not appear until 20 or more years after exposure to a carcinogen. Or they may cite evidence that not one but several mutations must occur inside the cell before transformation takes place. I have no argument with those assertions. In fact, I explain in a subsequent chapter how my theory predicts that the cancer-initiating mechanism in any modern animal ought to be both complex and time-consuming. However, I am not attempting to describe precisely the present-day cellular mechanisms that lead to cancer. Rather, I am developing a new theory of evolution, an explanation of how animals came to exist. My highly compressed and abstract description is consistent with the evolutionarily significant cancer facts: the carcinogen-mutagen correlation, the presence of oncogenes in normal body cells [it's been established], and that it starts in one cell.)

Now for the second premise of my theory:

> *All animal lineages endured great losses of juvenile specimens to cancer, and most of those cancer deaths began with exposure of a single somatic cell to a mutagen-carcinogen. The theory also states that mutagen-induced lethal cancer did not occur in nonanimal lineages.*

Those premises--which are supported by a wealth of physical evidence--are all I need to invite cancer into evolutionary theory. And I do not propose to sneak the dreaded killer through a side door and assign it a modest role in the history of life on Earth. No, as disturbing as some may find it, I insist on escorting cancer through the main entrance, in full view of everyone, and openly enthroning it. For I will establish beyond

doubt that without cancer there would be no complex life on this planet. Not a single brain cell, no intelligence and no civilization. Without enormous numbers of cancer deaths, not even worms or insects would exist, for contrary to what we have all been taught, the other processes involved in evolution, especially including natural selection, lacked the power to cause the origin and evolution of complex animals. Cancer's brutal and efficient extermination of imperfect juveniles was central to the process.

But to begin to understand the role that cancer played in animal evolution we must do some more work with black boxes.

The next black box substitution exercise is based on the widely accepted biological principle of *selection pressure*. That well-known phenomenon can perhaps best be explained by citing the case, familiar to all biologists, of the British peppered moth, *Biston betularia*.

Until the middle of the 19th century, this moth was grey. That color gave the moths excellent camouflage protection whenever they alighted on the bark of trees, for the trees were covered with greyish lichen. Predatory birds couldn't easily see the grey moths against the grey background and tended to ignore them.

From time to time, however, the *Biston betularia* produced a black moth. The genes for black moths were rare, and because their black color made them stand out against the grey lichens, and thus visible to the birds' sharp eyes, they remained rare.

Then the Industrial Revolution dramatically changed the environment for *Biston betularia*. Factories began to belch black smoke into the English countryside. The lichens on the trees died from the pollution and the bark darkened. The moths' world had been turned upside down. Now the rare black moths were less likely to be seen and eaten, while the plentiful grey moths stood out against the black background and were easily spotted by the birds and devoured. In a few years, the population of *Biston betularia* changed. Black moths became plentiful and grey moths became rare.

The survival of the moths demonstrate the power of selection

pressure. The very existence of the moths' *gene pool* was threatened by the blackening of the trees. (A gene pool is simply all the DNA in a population of related animals among whom there are no physiological or geographic barriers to breeding.) If the genes in that lineage had not produced at least a few black moths the species would have perished. But the moths' gene pool was able to survive the upheaval in the environment. It did so by making more animals with black coloration and fewer with the grey. The "mix" of genes in the pool changed in response to selection pressure.

It is important at this point to note that the surviving population of moths became black (contemporary naturalists who observered the change estimated that the population changed from 99% grey to 99% black) because *two* different events occurred over and over again. First, the black ancestors of the survivors bred. Secondly, *large numbers of grey non-ancestors were killed before they could breed.* Both kinds of events were necessary for the change to the predominance of black moths.

I have gained the impression that the second of these two *equally important* kinds of events is frequently slighted by biologists. Despite the clarity of the moths' example, the idea that deaths of nonancestors influenced evolution has a counter-intuitive feel about it. Many teaching biologists, perhaps because they do not understand it, or think it unimportant, ignore it. In typical college-level biology and genetics texts--I've looked at many of them--the authors place great emphasis on the rudiments of heredity mechanics, of how parents transfer their genes to offspring. But it is inescapable that all living things, including humans, have been determined to a large extent by the fate that befell their nonancestors. I will return to that intriguing, counter-intuitive and crucially important idea in Chapter Four, but for now I must explain cancer's fundamental role in evolution.

Because my postulated losses of juvenile animals to cancer would have had a direct effect on evolution--by killing the animals'

genes--I can call the event shown abstractly in Figure One "cancer selection." The cumulative effect of the pressure of cancer selection on surviving gene pools is shown in Figure Two, Black Box Exercise II.

Just as the *Biston betularia* gene pool survived because it produced fewer of the highly visible grey moths and started to produce more moths with coloration that concealed them better in the new environment, any *surviving* gene pool (any that is now creating animals) that endured losses to lethal cancer in the past responded to that threat by producing animals that did not die of cancer until they had produced the next generation.

This simple cause and effect relationship is shown in the first black box in Figure Two: when a surviving gene pool was subjected to cancer selection pressure--when cancer killed a significant number of juveniles--it responded by producing animals that were different from those that died. Just as the *Biston betularia* gene pool produced moths with the more protective darker coloring, so did gene pools under attack from cancer produce animals with better cancer defenses than those that had died. The validity of the cause-effect sequence--cancer selection causes cancer defenses--is self-evident:

> *Because any gene pool that did not produce in sufficient numbers organisms capable of surviving powerful and sustained threats to its existence eventually ceased to exist, we can conclude that all existing gene pools produced animals equipped with defenses against all threats that actually imperiled the gene pool in the past.*

The next two black box substitutions are crucial to understanding the biological function of cancer and my theory of evolution.

Since, by definition, cancer cannot start unless something goes wrong during cell division (mitosis) it is obvious that precise error-free mitosis will avoid cancer. We can now make our next black box substitution. We can substitute "Precise Mitosis" for "Cancer Defenses." If there was actual selection pressure from cancer in the past then it led to increased precision in mitosis.

Before making the next substitution we need to consider, briefly, the

relationship of mitosis to the construction of an adult animal.

Because our imaginary black box animal is a sexually reproduced multicell we can state with confidence that it began life as a single cell, as a *zygote*--a fertilized egg. We can also state that if it lived to reach the adult form it would consist of a number of cells. How many? If it were a nematode, a microscopic worm, less than one thousand; if it were an elephant, many trillions. But regardless of the number of cells in the mature animal we know that the transformation of a zygote to an adult--the process biologists call *development*--is the result of cumulative mitosis.

I have more to say about development in later chapters, for it is an extraordinarily complex and vitally important process, but for now all we need to know is:

Development is mitosis.

That relationship is self-evident. Whenever a single cell (zygote) becomes a multicelled animal (adult) the process responsible for the transformation is the repeated creation of new cells by division--mitosis.

We can make our final substitution and show that the result of cancer selection was "Precise Development."*

The validity of my substitutions, and my logic, can be judged by considering all the methods evolving gene pools might conceivably have devised to defend developing animals from lethal cancer.** There was a limited number of tactics or mechanisms available and I believe this is a summary of them all:

---

* Without precise development, "like" could not beget "like." The first element of neo-Darwinism I listed in Chapter One is the fraud.

** Like certain other evolutionists I will occasionally write as if gene pools were conscious entities. This is strictly a metaphor used only to facilitate explanation. They never were conscious.

1. Gene pools could have protected themselves by shielding the animals from exposure to mutagen-carcinogens. By protecting dividing cells from natural mutagens replication errors (and the initiation of cancer) would have been decreased; lower error rates in cell production enhanced precise development by the genes.

2. The lineage could produce animals that would maintain extreme mitotic efficacy even in the presence of mutagens. Among modern animals, that defense is most apparent in the insects.

3. The genes could create animals using a minimum number of somatic cells in each organism. By using fewer cells per organism they would have decreased mitosis, decreased errors in development and decreased cancer risk.

4. Animals could be constructed using a significant number of somatic cells that do not divide once they themselves are manufactured. Cells that avoid mitosis cannot, by definition, be transformed into cells that divide excessively. In humans and other vertebrates all muscle and nerve cells are post-mitotic. So are almost all insect cells. Once the post-mitotic cells are formed the possibility of their having cancerous offspring is completely eliminated.*

5. Gene pools could create animals with body plans that were relatively easy to replicate. Simplification would reduce the possibility of replication errors.

6. Mechanisms inside the cell could repair damage caused by mutagens before the oncogenes activated cancer. (Modern re-

---

* There is of course a cancer risk when the cell is formed in infancy. Some human babies die of cancer that starts in neurons.

searchers have discovered enzymes that repair damaged DNA.)

All six of those mechanisms would *avoid* the initiation of cancer by avoiding irreparable errors during mitosis. Errors in mitosis interfere with development. Avoiding them automatically enhances precise development.

The following devices would have worked *after* initiation of steps that could lead to cancer:

7. The body could expel cells that were cancerous or potentially cancerous. In humans and other vertebrates cells in which mutations have occurred are routinely sloughed off in certain tissues, such as the lining of intestines, and leave no mutated--potentially cancerous--offspring. Some worms seem capable of *autectomy*, or self-surgery, and may use that device to rid themselves of tumors.

8. The body could acquire complex systems that would actively seek out and destroy cancer cells after their formation. That is how the vertebrates' immune systems defeat cancer.

The successful functioning of those post-transformational anticancer defenses (or any others that exist) in a juvenile would have had the same result as any that *avoided* cancer: the animal would not die of the disease; the effect of the mitosis error on its development would have been overcome and, barring other mishaps, the animal would mature and reproduce.

From an evolutionary standpoint:

The cumulative result of cancer selection in any gene pool was to enhance the DNA's control over the cell-by-cell development of animals.

Once functioning oncogenes were present in all cells and once cancer selection was established, the potential for the evolution of ultra-precise replication in developing animals was assured. Since young animals that avoided cancer death could survive and breed, those properties that enabled them to avoid, or to correct, development errors were preserved and passed on to the next generation. But if its defenses failed and the young animal perished, its genes were purged from the gene pool. Cancer selection, evolution's watchdog, ensured that *only* genetic material capable of precisely executing the development program survived and multiplied. It created a win-win condition in favor of precise development.

We can now see that cancer is a biological function:

> *Cancer enforced an imperative of precision. It demanded exact implementation of the genetic program inside the nucleus of all somatic cells.*

My theory introduces the concept of *quality control*--the assurance that genetic material was precisely transmitted to all cells--into the evolutionary process. The old theory's emphatic assertion --that the most awesomely complex things known to exist were built without *any* evolutionarily-effective quality control mechanisms operating at the molecular and cellular levels--is an absurdity. It is an idea so lacking in worth that it warrants no further consideration by serious evolutionists. The old theory functions adequately as an explicator of the evolution of mushrooms and jellyfish, but those simple multicells mark the upper limit of its heuristic power. A theory of mushroom evolution cannot explain how complex animals came to exist.

Now I must warn skeptics; they have passed the point of no return. Unless they have found something wrong with the logic of my black box substitutions or have reason to find my postulates profoundly unrealistic their skepticism is nothing but a pose. A carelessly adopted pose. By agreeing with my substitutions they have accepted my logic. They agree

with the asserted effect that cancer selection *would* have had on lineages, *if* it had occurred. Establishing that cancer selection *did* occur will be easy. All intellectually honest persons who accept the logic of this chapter and who follow my arguments in favor of the actual occurrence of cancer selection will reject neo-Darwinism.

Anyone who thinks I've made an error in my reasoning is encouraged to let me, and everyone else, know about it. I don't expect to hear from anyone, however, for rejection of my logic requires the supposition of a physiological defense against a lethal disease that begins with *imperfect* replication which would not have aided *perfect* replication. Such a defense is utterly implausible. It cannot exist. As for the possibility that my postulates are unrealistic, although I have gathered (and present in subsequent chapters) a great deal of evidence in their support, the following brief discussion ought to allay the fears of anyone who thinks I have gone too far--and dash the hopes of those who wish that I have.

Is there any evidence that oncogenes exist in all cells of animals?

Oncogenes have been found in the normal, healthy somatic cells of all vertebrate species (which include mammals, birds, reptiles, amphibians and fish) investigated to date as well as in insects and nematodes. (I will cover this subject, and other modern cancer evidence, in Chapter Eleven.)

Skeptics especially should note that although my theory was not published until after the finding of oncogenes in normal cells, it was in writing, had been sent to (and rejected by) a number of scientific journals and was registered at the U.S. Copyright Office *prior* to their discovery. I concluded *in 1978*--entirely as a result of theorizing--that animal evolution could not have occurred unless functioning oncogenes were in all cells. That's exactly where molecular biologists found them--*in 1981*.

To give some idea of the surprise and puzzlement the discovery of cellular oncogenes caused in certain quarters, this is what the British weekly *The Economist* had to say in September 1981:

> what on earth are [oncogenes] for? Nature would not have evolved genes specifically intended to produce cancers. There would be no

> advantage whatever in that. Yet it looks as if [oncogenes] have an old evolutionary origin and have survived natural selection to climb right up the evolutionary tree of species.

The Economist's science journalist correctly saw that cellular oncogenes made no sense whatsoever in terms of the neo-Darwinian theory of evolution. But professional evolutionary biologists, who are collectively responsible for seeing that one of science's most valued theories keeps pace with all new and relevant scientific research, ignored the momentous discovery. They failed to realize that genes of great evolutionary age that routinely kill modern juveniles flatly contradict neo-Darwinism.

But if nature only retained genes that help organisms why were genes that cause cancer selected in the first place?

The genes that now cause cancer were originally selected because they performed another function, one beneficial to the organisms. In the earliest multicells, which were much simpler than animals, rapid, vegetative-like growth was not only not lethal but actually helped organisms to survive. Such growth is observable in modern plants, which characteristically grow aggressively and opportunistically, not unlike cancer cells.

Additionally, there is considerable evidence that animal oncogenes still function beneficially--by encouraging rapid growth--in the earliest stages of embryogenesis and in regenerating tissue damaged by trauma. When those routine high-growth periods come to an end oncogenes are normally deactivated by other genes.

Although my theory is about the evolutionary effects of lethal cancer and not its origin, I provide in Appendix I an expanded plausible origin scenario.

Other than the Ames correlation, is there other evidence that mutations are involved in cancer initiation?

There is a great deal of medical evidence linking exposure to radiation

and other known mutagens to specific cases of cancer. Moreover, the molecular biologists have confirmed it. Natalie Angier, a science journalist who has written extensively about the molecular biologists' research on oncogenes, has reported, "Only when the [oncogenes] are mutated do they become agents of death." I review other evidence for the mutagen-initiation of the disease in Chapter Eleven.

But if molecular biologists have identified mutations of specific genes as initiators of cancer, why would cancer selection have encouraged retention of mechanisms that reduced all somatic mutations?

If cancer is hundreds of millions of years old then nature has been moderating, for all that time, the molecular mechanisms that initiate it. Logic tells us that as animals accumulated molecular defenses against cancer the initiation process became both more complex and more time-consuming. A corollary to that conclusion is that the initiation steps were simpler and quicker-acting in the past. Furthermore, although the theory does not depend on the validity of this idea, it is entirely possible that other somatic mutations (which may have no dire effects in modern animals) initiated cancer in the distant past.

Even if initiation could not start unless the oncogenes were themselves mutated, no intelligent being looked over the shoulder of the evolving gene pools, no mentor advised them to avoid only those replication errors that caused cancer. Selection was blind. Mechanisms that reduced *all* copying errors (opaque external coverings, for example, which shield the entire animal from natural radiation) would have lowered the incidence of errors that caused cancer. They would have been selected.

Is cancer found in animals other than man?

Yes. The Smithsonian Institution's Registry of Tumors in Lower Animals gathers reports from around the world of cancer findings in animals. The Smithsonian experts have examined specimens and other physical evidence and have determined that cancer has occurred in mammals, reptiles, birds, fish, insects, mollusks, and in flat worms (*Platy-*

helminths).

The finding of cancer in *Platyhelminths* is highly significant. The most primitive of the living animals, they are possibly not very different from the primordial ancestors of all animals. The discovery of cancer in them (which, incidentally, also occurred *after* I had developed my theory) is strongly supportive of my claim that the animal lineages and cancer began at the same time.

--and in nonanimals?

Not a single case of cancer has been found in any plant or sponge. No one has initiated cancer in any nonanimal, including the *Cnidarians*. Some marine biologists have reported finding anomalous growths in stony corals (members of the *Cnidaria* phyla) off the coast of Florida that may be cancerous. Since this theory asserts that cancer selection played no significant evolutionary role in the life history of any of the nonanimals, including stony corals, I comment further on that ambiguous finding in Chapter Eleven.

What evidence is there that cancer starts with a single cell?

Researchers have initiated leukemia, cancer of white blood cells, in healthy mice by the transfer of a single leukemic cell from a mouse that already had the disease. The mice that received the cancer cell promptly died of leukemia. In addition to that laboratory evidence, there is that frequently under-utilized scientific tool, logic. It is much more probable that a lethal disease characterized by rapid cell division began once in a single cell than that it began separately in two or more cells.

Were mutagens-carcinogens present in the environment throughout the evolutionary period?

The most ubiquitous mutagen-carcinogen on our planet at this moment is not some man-made chemical. It is not even a substance. It is ultra violet radiation. *Sunlight*. Although all extant animals, including man, have elaborate defenses against many cancer-causing agents, including ultra violet radiation, the evidence strongly supports my pre-

sumption that sunlight was the primary cause of evolutionarily significant cancer, that it killed juveniles in astronomical numbers. I make substantive arguments in favor of heavy losses of genetic material to sunlight-induced cancer later in the book. For now, however, I will mention only four significant facts:

> *1. The fossils show that for about 400 million years* all *animals shielded* all *their somatic cells from exposure to direct sunlight.*
>
> *2. Most animals now living* never *expose a* dividing *somatic cell to direct solar radiation.*
>
> *3. The only modern animals that regularly expose dividing cells to direct sunlight (humans and certain other vertebrates) have powerful secondary defenses--immune systems--against cancer.*
>
> *4. From the beginning of their life histories until now, plants and most other nonanimal multicells, which my theory says were* not *subjected to cancer selection, continually exposed unprotected somatic cells to intense solar radiation.*

My postulate of heavy cancer selection in animal lineages and its absence in nonanimals explains that otherwise baffling historical record. Significantly, neo-Darwinism says nothing about it.