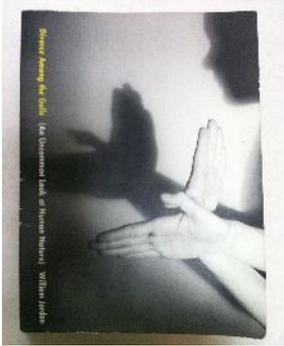


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Cockroach Memoirs - pages 102 to 126

Stern was the sort of professor a college boy could admire in the early 1960s. He was a big, square-faced, clean-cut man who wore plastic-rimmed glasses and white short-sleeved shirts with ties. As a young man he had ridden the rails from the Midwest, erupted from a boxcar somewhere in the great Central Valley of California, and landed running; he hadn't stopped until the war was over and the GI Bill had seen him through to the university post he now held. He was blunt, decent, good-hearted, with no affectations and no time for people who played games.

Stern was also an earnest, concerned teacher who asked creative questions, questions that required a student to think, not merely to memorize. The upshot was that Professor Stern reached me. I received an A in the course, and when the time came to plan my graduate school admissions campaign, Doc Stern was the man on whom I piled a heavy load of hope.

I was turned down by all my choices except San Diego State University, which was required by policy to accept me (and it did so with the proviso that I maintain a 2.5 grade point average), and the University of California, Berkeley. So off I went to the educational Camelot by the Bay of San Francisco in the fall of 1966, everything I would need to pitch camp piled in to my red VW, my beetle. I found an apartment on Regent Street near Dwight Way, the ground floor of a white clapboard house no more than a hundred feet from what would become People's Park within the year, and I settled down to study insects. At least, that's what I thought I'd study.

Straightaway I had what proved to be a premonitory experience. One morning I sat down to breakfast, intending to read the San Francisco Chronicle, which I had brought in from the front porch. I slipped off the rubber band, and just as I opened to the front page this thing the size of a teabag exploded from the classified ads, flew flipping and scrambling through the air over to a pile of old papers by the fridge, and disappeared. As my feet left the floor and the Chronicle flopped toward the ceiling, I recognized the object for what it was a specimen of the American cockroach, *Periplaneta americana*.

Grabbing an empty jar, I closed cautiously on the spot where the roach had disappeared, the Arts section, and gently, very, very gently, began opening the pages. The thing seemed to anticipate my moves, though, and before I

could react it catapulted into the Metro section. I reached for that, and at the instant my finger touched paper it sprinted over the edge of the pile and wedged itself into the Classified Ads, Personal Message section. I pressed the paper down beyond the creature so it couldn't squirm away between the sheets, then lowered the jar.

Finding all escapes blocked, the roach then did what any creature would do in a similar predicament: it panicked. It scrambled hysterically, legs blurring, body bouncing off the sides of the jar, falling on its back, flailing onto its feet, and, finally exhausted, coming to rest with its head pressed to the floor.

It lay there looking forlorn-but not being forlorn, of course. Forlornity is a kind of self-pity, and self-pity requires self-conscious intellect; yet somehow this insect gave the impression that it did realize its predicament, that it did address the situation with something more than pure instinct. Then the tips of its antennae began to move, almost imperceptibly. Like tiny, thread-thin snakes they pushed into the juncture of glass and paper, the tips probing and poking, the shaft following flexibly behind, sliding next to the inside lip of the jar caressing a crescent of paper with a personal message printed on it: 'W. J.-It's formaldehyde disinfectant in water. -Louise.' What becomes of one's words when they leave home and go out into the published world, my friend, is random fate.

I kneeled down to contemplate the prisoner. It lifted its head slowly, its antennae palpating the air in slow, alternating strokes, and gazed at me. Its eyes glinted in the morning sunlight. I knew that what looked like two huge eyes covering the contour of half the head were actually two honeycomb aggregations of ten thousand? - twenty thousand? - I didn't count - hexagonal lenses called ommatidia. Each ommatidium was said to form one point of light of a composed image in the creature's mind. The eyes looking back at me were supposed to create coarse pictures of reality, like very poor newspaper reproductions, or so the theory went. But what else lay behind the eyes? I knew this creature could have no intelligence. A soul? . . . absolutely not. These questions fascinated me. What laws, what programs, lay behind the actions of this small creature? What programs and laws informed my own brain? I had come here to study insects, but I knew then, somehow, face to face with a cockroach imprisoned in a jar atop the Chronicle, that the questions glinting from those strange, wonderful eyes would not end there. I knew that they would lead back someday to me and my own species.

Meanwhile, my academic rebirth got off to a rousing start. Realizing that the next step in my education would occur in Vietnam if I failed to pass muster at the University of California, I earned straight A's for the first year and a half of my graduate career. I was bearing down on the exalted title of Ph.D., doctor of philosophy, doctor of insect philosophy, and doing so well that I was asked to teach the laboratory of a course called Insect Morphology and Physiology, Entomology 102. Ah yes, and because the cockroach in its various species is the entomologist's answer to the laboratory rat, part of my duties would be to raise them in large masses. Purveyor of roaches, that was me.

The breeding and rearing were carried out in special containers called 'cultures,' originally intended to be garbage canisters. But they were light in weight, waterproof, and had tight fitting lids into which windows could be cut for ventilation. On the container floor we placed four or five

pieces of cardboard for shelter and tossed in a few handfuls of dried dog food. For the water supply we filled a small bottle and plugged it with a cotton wad. The roaches could chew on this to extract the moisture, but the fluid could not flow out and flood the colony. And to ensure that the roaches would not escape through the tiniest space between the container lid and lip (though inevitably some always did) , we slathered Vaseline around the can's inside rim.

Depending on the needs of the course, I kept between five and eight cultures lined up in two rows down the middle of the roach room. These contained four species that more or less represented the world. I had barrels of German roaches (*Blattella germanica*), small, delicate creatures that scurried away like windblown feathers whenever they escaped; Madera roaches (*Leucophaea madera*), a beautiful gray species from Africa with what appeared to be veined leaves for wings; and Cuban burrowing roaches (*Byrsotria fumigata*), two-inch wonders that gave off a sweet, fruity aroma and had bands of armor across their backs like living trilobites. And of course I reared the mainstay of the laboratory, the good old American roach (*Periplaneta americana*), the big brown water bug that scrambles behind the toilet or into the pantry when the lights come on. In the cockroach cultures, however, a scared roach had nowhere to go but under the cardboard, and if ever I lifted off a lid without warning, the garbage can would emit an explosive WHOOSH as several thousand roaches, German, African, Cuban, and American, dived hysterically for cover.

This universal reaction was just short of a seizure in its intensity, a panic in which a roach would hurtle, wings flapping and legs flailing, over anything in its way, including a human being. More than once, when I reached into a culture to grab a few roaches for some experiment, four or five individuals would scramble instantaneously up my arm, spring off into the room, and escape before I could so much as flinch. There's no denying it--the handling and rearing of roaches will never be called a pleasant task, but it was my job, and the job had an unannounced benefit: It started to reveal things about the people in the lab. I recollect one incident in particular. Shortly after I assumed command of roach production, I decided to stop on my way home one night and check the cultures. It was late, around 11:30, so I was surprised to find the lights on in the rearing room. I opened the door and found Arnold there. Arnold had taught the laboratory and tended to the needs of the roaches during the previous four years. He had taken me under his wing, as the saying goes, and tutored me in the art of cockroach care and maintenance.

Arnold, whom we had called "the Viking," blond and fair ice-eyed, frozen-faced, monolith-minded, six foot four and massive. Arnold, who, when I had taken his course, had stood in the back of the room with arms crossed over his massive chest and scowled as we dissected our roaches and ran our tests. Arnold, with his eyes glaring back in the deep-set caverns of his skull. That same ironic Arnold whose hulking form completely belied his spirit. For Arnold was almost effeminate in his habits and sensibilities.

He cut his food in squares and aligned them corner-to-corner on the prongs of his fork. He carried Kleenex individually folded in perfect little squares. He fussed and dusted and washed compulsively to keep the lab and rearing rooms immaculate--the cleanest, most hygienic roach hotels the world has yet seen.

As I entered the room, Arnold was leaning over one of the culture cans. He appeared to be hugging himself, and I saw that he was clutching the canister lid in a kind of fetal embrace. I sensed that he was angry but had no way of knowing the extent of it.

'Hi, Arnold,' I said, starting off with the gambit of cheerful non-chalance.

He ignored me, refused to turn around. For an instant I thought he was trembling.

'Arnold' I said, 'is anything wro...'

Without the slightest warning, he whirled around. 'GOD DAMN YOU,' he bellowed in a dead, sepulchral voice that still reverberates from the walls of my memory. He picked up the entire roach container and thrust it at me.

"LOOK!"

I took the container and peered cautiously into it. There, at the bottom of the pit, was the worst sight I ever saw in Berkeley. One of the water containers had come unplugged, flooding the floor and turning the contents of the canister into a soup of dog food and dissolved cardboard. A layer of dead roaches, mostly immatures, floated on top in a vile ferment of death.

I was deeply chagrined. Obviously I had not plugged the cotton wicks into the water bottles tightly enough; no one was to blame but me. I had eliminated from the face of the earth a thousand innocent roaches-and I do not say that lightly. All I could do was look up at Arnold's formidable countenance and beg forgiveness. But to my surprise I saw that his eyes were red and swollen. For a second or two I didn't understand; it was too incongruous. Finally it struck me that he was fighting back tears. The intensity of the moment was too much, however, and his grief burst loose with a great wrenching sob.

"The little ones," he bawled. "The eggs . . . they never had a chance!" And he lumbered from the room, moaning.

I was dumbfounded. Never, in the weirdest tales of entomology, had anyone been known to be devastated by the mass extermination of roaches. I realized, standing there with thousands of terrified roaches scrambling inside the various other cultures, that I and everybody else in the lab had taken Arnold at the value of his face and his monolithic mass. I saw now that Arnold's personality had been assembled without a sense of humor, without the ability to dance, soul to soul, with another person. He scowled and glowered because, try as he might, he could not communicate with humans, could not connect his kindness and love and deep loyalties with his own kind. If his own species could not or would not recognize his worth, he could only bequeath his kindness to the roaches. It seemed immensely sad, even pathetic, to see such goodness caged in a giant's soul, and I stood there and counted my blessings.

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I settled into the daily routines. The tasks of freshening the water, providing kibbles, and changing the cardboard became rote. Inevitably, however, I would find myself watching the roaches as I went about my work.

I began noticing the way they moved, the places they chose to rest, the push and shove of their personal interactions. It dawned on me one night that more was going on in the containers than met the casual eye. The roaches were going about their lives in a way curiously similar to the way we humans do. I began to wonder if Arnold might not have been so strange after all. I also began to find in the roaches a source of humor. But above all else, I caught my first glimpse of the kinship that unites the working of all brains, human, animal, or arthropod.

This kinship between roaches and humans first revealed itself in the area of aggression. One night I was feeding a colony of Madera roaches that had been without food for more than a week and were lying still, as roaches do, to conserve energy. I scattered a handful of dog food across the container floor. Immediately a thicket of antennae began to wave, slowly at first, then faster and faster, as if the antennae were broadcasting excitement from roach to roach, brain to brain. As the intensity rose they began sprinting about in fits and starts, running a few inches, then stopping to palpate the air.

A young male missing half an antenna found the first nugget of food, a piece nearly as large as himself. He seized it in his mandibles and, to my utter surprise, dragged it over to a protected space between two slabs of cardboard. The way he behaved—alertly keeping his body between the prize and his peers, standing over the food while gnawing with an almost desperate urgency—was exactly the way a stray dog would work on a bone, or a child guard her teddy against a sibling. While I watched, another roach ran off with loot, then another, and another, until all the adults were standing over their food, protecting it while they ate. You could almost hear them growl.

I then witnessed something else, and the silent growls became invisible screams. I had seen evidence of sinister happenings without thinking much of it, since so many of the adults carried the stumps of amputated feet, legs, and antennae; it seemed almost normal in the cockroach cultures, a spurious artifact, perhaps, of crowded living. One night, though, the significance of these injuries became clear.

I was about to go home for the evening and thought I'd take a peek at the rearing room before I left. I glanced absentmindedly into the Madera barrel as I made a quick round of the room. My eye was drawn instantly to the tension of an incipient fight. Such tension is universal, whether acted out by insect or human, and the attraction is likewise riveting. Two males had squared off.

The opponents stepped deliberately closer, stopping about a half-inch apart. Slowly they crossed antennae and began feeling each other out. In a strange, ritualized ceremony, both extended their legs until they looked like little raised platforms. They stood there for a moment, then, as if a bell had rung, lunged into combat, grappling, biting, and rolling about on the floor. This went on for fifteen or twenty seconds until one of the roaches abruptly broke free and tried to escape. The victor, however, followed in close pursuit; the two skittered under the cardboard, dodged among the kibbles, and clambered up and down the container walls until, exhausted, they stopped to rest. The battle continued in several bouts separated by short rests, but eventually both roaches appeared to lose interest, and the conflict died out.

Although I never found out how this particular rivalry ended (I was never able to identify them again in the seething canister, the pair probably fought several times more. It turns out that cockroaches held in close quarters form peck orders much like domestic fowl, wolves, apes, and the higher social animals in general. A series of confrontations determines who's boss, whereupon the loser defers to the victor and usually backs off without further fighting.

During these cockroach struggles, victory was not always enough, and the winner chased his rival relentlessly, as if to humiliate him. In these cases the loser groveled. He lay down, tucked his legs under his body, folded his antennae back along his sides, and tried to endure while the dominator chewed on his legs, wings, antennae, even on the edges of his dorsal plates, inflicting the damage I had noticed earlier.

On rare occasions, the loser died of stress. That, at least, is what we presume; it has been observed by other students of the cockroach, and no one has put forth a more plausible explanation. There were no wounds, no signs of damage. Thoroughly defeated, the male would lie down and simply remain there until, at some imperceptible point, his life slipped off to eternity and rigor mortis seeped in.

It was disturbing, somehow, that a young, vigorous creature, his entire life ahead, would give up in passive suicide. Even to a roach's brain, the prospect of interminable subordination and domination was evidently not worth the living. The next day I would find an entomological specimen. In the case of death by stress, the victim would become an exquisite shell of life, with the antennae, wings, legs, claws, and hairs still in perfect order.

Up to this point, about three years into my career as purveyor of roaches, I had assumed that such incidents were amusing parallels to human behavior and nothing more. To think that there might be some commonality in the workings of the animal and the human mind was ridiculed by the university crowd, who called it by the grandiloquent term 'anthropomorphism.' The term meant blasphemy: Read not the motives of Man into the dim-witted brains of vermin. The very premise was also, of course, arrogant and self aggrandizing, a kind of humanistic P.R. job. One cannot use the term 'anthropomorphism' without presuming a grand rift, a kind of holy chasm between the minds of animal and man that can never be bridged. Humans march to the tune of the rational mind, while abysmal creatures like the cockroach follow blind urges and deaf desires called instincts.

Yet I couldn't dismiss what I had seen. In some nagging way the notion of anthropomorphism went against biology. What if the intellectual establishment had it backward? What if, instead of imputing human thought to the animal mind, we should impute animal workings to the human mind? If indeed we had evolved from animals, what was the human mind but an extension of the animal's urges? But I was not yet ready to frame this idea, so I kept on observing.

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Sexual relationships were another of life's issues on which the roaches had comment to make, because they emphasized the intimate relationship between courtship and sex on the one hand and aggression on the other. Like most creatures, cockroaches do not indulge in free sex; in fact, they're very

choosy about their mates. Getting up a romance involves the twofold task for the male of shutting the female's defenses off and turning her desire on. In humans this can take hours even days or weeks, but in roaches it usually takes minutes.

The Madera roaches had the most obvious moves. I soon noticed that the females didn't like to be approached by undesirable males, or even by desirable males at undesirable times, and violently rejected their advances. The female controlled the situation. When she felt desire, she released a pheromone, a scent that appeals only to members of the same species. The males wasted no time in responding. Their antennae waved slowly as the molecules of scent activated sensors along the shaft; the neurons leading from the sensors to the brain began to click with bioelectric pulses; and the pulsating neurons stimulated other neurons pressed side by side in a larger cable of sensory nerves. After several moments of rising excitation, the males would begin to dart about, first in one direction, then, after stopping to test the air, in another. Eventually their random dashes brought them together with a female who was ready to negotiate.

Contact made, a pair stood face to face, caressing and intertwining their antennae. The male, apparently realizing that the female's interests were indeed prurient, then pivoted so the tip of his abdomen was almost touching her face. He fluttered his wings to blow his own scent over her antennae and turned back a round to see whether it was having any effect. If so, the female would now be flapping her wings impatiently. In a flurry of flailing antennae the male mounted her like a tiny, tiny dog. There they rested for sometime, completely motionless except for the slowly waving antennae. The proceedings evidently a "go," he then pushed himself off to the left, and still tethered by his aedeagus, rotated around so that they stood, still connected, facing in opposite but apparently compatible directions.

From this point on, a cockroach liaison was basically like a human relationship, at least so far as I could tell by watching. The pair would stand around, for hours on end, absorbed in the introspective task of transferring and storing sperm (for which the female has a special sac known as the spermatheca). As long as there was no need to move actively, everything was tranquil and relaxed. But sooner or later something would happen, the worst case being the approach of a human being, and an urgency greater than sexual bliss preempted the pleasures of love.

Each member would attempt to bolt in opposite directions. Something would have to give. Seldom was it the relationship. Roaches are sincere in their commitments, and once they join, they are usually yoked together in a bondage of interlocking gonads until the transfer of sperm is complete. No, what gave was the male. Being smaller and lighter, he was dragged along backwards by the female, wings fluttering, legs clutching at kibbles, pieces of cards board, other roaches, and writhing in general frustration, while his bigger and stronger mate decided where the relationship was heading.

As time went on, incidents like these collected in my mind, a compendium of the cockroach condition. Taken alone, they were little more than amusing observations, but eventually experience and theory met, and the human implications of cockroach behavior came into focus.

I don't recall how it began, but I do remember realizing one day that, try as one might, it was almost impossible to sneak up on my roaches and not find them alert, even after they'd been left alone for hours. There they'd

be, stroking the air with those ironically delicate, refined antennae, divining the news from molecules of air with Stradivarian refinement. It was impossible to suppress the feeling that they were, in some fundamental way, intelligent.

And the feeling was completely wrong—from the conventional, human point of view. The roach, measured for intelligence quotient, has almost none at all. Its mind is beneath stupidity; to be stupid one needs intellect, and the roach has nothing but instinct. It is strictly a monument to hard wiring. The cockroach has been shown to be capable of learning only the most rudimentary responses, like raising its legs to avoid a shock. In the interests of science, the creature is fastened in place, given an experimental cue, followed closely by a walloping shock. To make the science even more interesting, the roach is then decapitated and the headless corpse tickled with the pre-shock cue. The result is not merely interesting; it is fascinating. The legs pull up to avoid the shock, without any advice from the brain. The learning is in the peripheral nerves themselves!

Yet it was overwhelming to realize all that the roach could accomplish with its lowly instincts. One night, on the way home from the lab, I noticed a big female American roach walking in the street with a peculiar stiff-legged gait, like a child on stilts. I then noticed the remains of a peanut-butter-and-jelly sandwich, on which a stream of ants was converging. The roach had wandered into the crawling, stinging, biting multitudes, and she was reacting with the simplest and most effective of all defenses: holding her body above the masses and the flow. Intelligent? No. Learned? No. Just one of the instinctive programs wired into the roach's pinhead of a brain, programs that function remarkably like reason.

It struck me, looking down from my lofty altitude on this insect, that in the big view of things, all brains are intelligent. No, it sweeps wider still. Biology is intelligent. If you define the fundamental intelligence as the appropriate response to one's environment, then plants are intelligent; so are bacteria, fungi, even viruses.

Consider the intelligence of plants as they dance to the beat of the seasons. As winter wears on, plants mark the cold, and when they tally a certain time below a certain temperature, their physiology readies itself for the coming of warmth. With the onset of spring, plants measure the daylight and whether the day lengths are increasing or decreasing. Their physiology is crafted to act appropriately in when the day reaches a certain length. Plants know in the mind of their physiology when preparations must begin again for winter: when the leaves must stop producing food, when the pigments of fall must be prepared, when the joints between stem and twig must be dissolved so the leaves can fall to the ground. The dance of life with earth is sublimely appropriate. Existence is intelligence.

What I watched, then, standing over the roach, under the glow of the street lamps, was physiologic reason. On the level of blind, neuromechanical operation, reason and abstract comprehension are both built into the nervous system as fundamental properties. This idea, however, has to be read in the light of evolution.

Evolution is a corner stone of modern biology. A student or professional academic cannot get through a day without nodding to this or that ramification of evolution theory, and eventually one becomes so familiar

with the concepts and principles that they assume a style. There is a certain feel to the way evolution works, a stylistic imprint. Natural selection, the mechanism by which evolution works, spins in certain patterns, flows in certain courseways.

With me the process has gone beyond style. The day came when evolution became a full-blown character, whose looks and habits reflect the way he works. He is, to be blunt, a slovenly fellow. He does only what must be done to keep a species going, and he never attends to anything until the last minute. In my mind's eye he looks grubby, like a mechanic, or like Vulcan, the Roman god of black-smithery. But he has the incongruous talent of a celestial jeweler. He works with molecules. His masterpiece is the miraculous necklace of DNA, and by working the molecular beads he creates dinosaurs, plants, bacteria-the countless millions of species that have played their roles on earth since life began. We, with our enormously expanded brains, are merely another of those species.

One of Evolution's most intriguing operations is described by what might be called the Law of Used Parts. Everything Evolution makes, he makes from used materials. To make a lizard, he had to use the frog; to make a bird, he started with the lizard. The bird was tricky, a much harder job than making the lizard from the frog. The reptilian skeleton, the metabolism, the circulatory system, all had to be retooled. Evolution converted the front legs into wings, transformed scales into feathers, made the bones light and strong and hollow, connected the hollow spaces directly with the lungs for internal cooling in flight, and upgraded the eyes and nervous system for the split-second demands of aerial acrobatics. That is how Evolution always works: bending this, compressing that, lengthening, expanding, inflating, dividing, engraving, sanding, polishing.

So how did Evolution alter the monkey to create this mind of ours? There are, unfortunately, no witnesses. One thing, though, is clear. The human brain is a jury-rigged device, and the mind reflects that fact. A thin layer called the cerebral cortex generates conscious thought, they say, the kind of thought we label "reason." Evolution has laid the cortex over a region of gray matter three inches thick, a region that generates feelings, urges, intuitions, and desires. Reason is therefore wrapped around emotion-not, it seems to me, the best design for a machine whose purpose is to produce logic. Logic and the conscious mind are therefore driven by emotion. What chance does a thin membrane of reason have of containing a thick lump of urge and desire, impulse and reaction?

Why, the whole mechanism of conscious comprehension is an emotional thing! If you stop and turn your senses inward, you can even feel the mechanism work, can feel it churning about in that cluster of subconscious neurons called the reptilian complex, where the ancestral lizard still holds court, raising its crest toward rivals and prospective mates, scanning the world for enemies. The impulses that issue from the lizard's court pass on to the surrounding neurons, which form a center known as the limbic system or neon pallium. It is the heirloom of the ancient mammal-hat rodentine insectivore which emerged from the reptiles. The limbic system adds the feelings that produce the "four Fs"-fighting, fleeing, feeding, copulating-and this melange of ancestral urges comes roiling into the cerebral cortex, the brain's most recent layer, the layer of "reason." There it becomes a conscious thought as it is packaged into words, sorted into phrases and sentences, weighed and analyzed, and if deemed appropriate, emitted into the

world through the mouth, the written word, the vote, the unspoken consent, or some other avenue of dispensation.

The process works both ways, of course, and conscious thoughts received from without are relayed down to the ancestral centers, which leads to dialogue with the world.

And what of humanity, that great summation of the entire species' thoughts and actions? Having to start with the monkey, how did evolution manage to fabricate the human's image of itself? A few modest speculations suggest themselves.

Take courage, for instance. A quality arising, perhaps, from the urge to resist domination by the very large male, the neighboring clan, the predatory beast. Evolution has a way of building character from such primitive parts. And genius-what primal traits has Evolution fused to produce that? Creative cleverness, without question, but just as crucial are the dashes of aggressiveness, persistence, and irreverence to produce boldness of thought, to defy convention and push beyond the boundaries of accepted and acceptable thought. Religious faith? Awareness must be at the core, an awareness chained by intelligence to that most primal of all urges, the urge to survive.

But a quick look around confirms the most primal of all anxieties: every one dies; It isn't always going to be oblivion. It is almost conceivable-and the hairs rise. And the intelligent mammal runs back to the source of life, to the parent who brought its inchoate being into the world, nurtured, sheltered, and defended it, and, now grown into the adult stage, the intelligent mind conjures the adult parent, the omniscient, omnipotent, invincible concept that defends the soul. Infinity, eternity, cosmos: the anxieties of intelligent survival are all taken into account by the religious urge.

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In the end the roaches revealed to me an overarching view of life which placed the human mind in a different perspective from the one mainstream society teaches its members. It is an eccentric vision without question. But it seems to conjure a sense of tolerance and comfort, for it recognizes the kinship of mind.

The insect brain is laid out in fundamentally different patterns than the brain of mammals, yet it generates behavior that is remarkably similar in dealing with the basic tasks of life. At least to that extent there seems to be a similarity of mind. The mammals, however, share the basic structures of brain, and the differences are a matter of degree. So is the mind; an honest person cannot avoid this conclusion.

In other words, the human mind is an extension of the animal mind-a variation on a theme-not a celestial novelty. Which means that intellect is essentially a weapon/tool wielded by the ancient appetites, anxieties, revulsions, moods, and kindred urges.

As my simple insects acted out their lives, I was struck by the intelligence of instinct, the appropriateness and common sense of actions designed for life in a certain place. I came to the conclusion that what we humans call common sense may, at its very foundation, be nothing more than good

instincts. What we call the conscious mind might simply be a program that overlays the instincts, the innate intelligence of the unconscious nerves, and watches them operate. It is as if self-consciousness is the ability to monitor our programs (instincts) and, at the right time, make connections among them, among memories, mechanical comprehension, emotions, urges. Maybe that is what we experience as rational thought.

The simple truth is, humans, like all animals, spend the majority of their lives pursuing food, territory, social position, and mates. The chase isn't quite as direct as it is with the less cerebral creatures; money complicates things. But money is nothing more than a tool for conducting the eternal quests.

Odd as such conclusions may seem, they didn't disturb me a bit. They were humbling, because they were universal. They included all living things. Morally neutral, they made sense of human excesses, of actions that a truly rational creature would never perform. In the end, I was amazed at what Evolution had made by exaggerating the monkey.

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I do not want my cockroach memoirs to leave the impression that Evolution has no warts, for in truth there are some rather embarrassing flaws in its character. The evidence is shot like excess fat throughout the substance and essence of nature, and, consequently, throughout human nature as well.

Evolution is first and foremost a cheapskate. I did not want to emphasize this earlier, when I mentioned that it uses nothing but second hand parts; that new species are always created out of old; that nothing is ever conjured, full blown, from new materials; but cheapness is what it comes down to, and inevitably it shows in the product. I shall illustrate this as soon as I dispense with the second flaw, that Evolution is, to be blunt, a confirmed sloven.

It deals with problems only when forced to. An ice age comes, and then it fashions fur coats, wasting countless lives in the process of natural selection. It never plans ahead, never prepares a species before the change occurs, but patches and sews and tries to keep the old alive. And always there is that matter of used parts; the upshot is that every living thing is a jury-rigged device.

All of which blasts the persistent rumor that Evolution seeks perfection. Evolution cares not one whit for perfection; what it cares for is refinement, sophistication, and it cares passionately for that. But there is no relationship between perfection and sophistication. The poor tuna fish bears witness.

The tuna is one of those creatures that make people lift their eyes to heaven and moan, ''Here indeed is perfection-there must be a God!'' and at first glance they would seem to be right. After a meticulous examination they would seem to be more right. The creature before them is probably the most sophisticated fish in the sea. Its form is a masterpiece of hydrodynamic design, its shape ideal for high speeds. Fins fit into slots and grooves; eyes lie flush with the surface of the pointed snout; finlets on the caudal declivity break up water turbulence. The tuna is a piscine missile which, in the case of the giant bluefin, can reach speeds in excess of fifty-five miles per hour, can dive or ascend a thousand feet in the

space of a few minutes, and has not a concern in the world for the dangers of decompression.

The reason for these abilities is that the tunas (the seven largest species, to be precise) are warm-blooded. Astonishing as this may seem, it is true, and the advantage is clear, because warm muscle develops far more power than cold muscle. Warm-bloodedness makes for superior performance.

However, endothermy (internal heat production) in a fish is almost blasphemous to the laws of physics. The blood, which cannot help picking up great quantities of heat from the body, must pass through the gills to absorb oxygen from the sea, and gills are ideal radiators; nothing loses heat so fast as a radiator-gill. Evolution has solved this dilemma brilliantly by laying the outgoing vessels in direct contact with the incoming vessels. The outgoing vessels carry blood laden with heat; the incoming vessels carry chilled blood from its journey through the gills. So the cold blood loaded with oxygen absorbs the heat and carries it back into the body. Evolution has refined the tuna's circulatory system into an exquisite heat exchanger. It takes the place of blubber or fur.

But for all its sophistication, the tuna is still a fish. It is limited by the law of legacy, or, if you will, the law of used parts.. Because water holds a mere fraction of the oxygen held in air, the only way a tuna can meet its metabolic costs is to swim fast with its mouth partially open, ramming water over the gills. Ram-gill ventilation allows a tuna to process enormous quantities of water, but here, finally, the inherent limitations of the fish catch up to sophistication. The tuna must pay a steep price for its warm blood.

In the pursuit of refinement, Evolution has jettisoned the muscles and the innervation of the gill muscles; the tuna, unlike less sophisticated fish, cannot lie stationary in the water and breathe by gulping. It must swim above a certain speed in order to meet metabolic costs. If it stops it suffocates. If it stops its body temperature also drops because the tuna generates its body warmth through exercise. Therefore, the tuna has warm blood because it swims fast; the tuna must swim fast because it has warm blood. The individual tuna is locked into a circular fate in which it must swim without cease, until the day it dies. The species, too, is fated to swim endlessly, for the rest of time, because it cannot go back to the ancestral motion of gulping water.

So what appears on the surface to be perfection is actually the curse of hyper-sophistication. Refinement has become, if not a liability, a relentless and onerous responsibility.

I believe that the human brain is another example of hypersophistication. In its blind pursuit of human percipience, Evolution has created a device which has been riddled with monumental, perhaps insurmountable, design flaws. They reveal themselves in the way that the mind embraces the world.

Perceive is the key word. The various senses send their messages along the sensory neurons in coded pulsations. The brain then interprets the code and, like a television camera, assembles a perception.

Perceptions are accurate, by and large, otherwise we could not drive down the driveway without smashing into one thing or another. But the human mind cannot leave perceptions alone. It wants to understand what the perceived

thing is, how it got there, where it is going, how it fits into the world-what the world is-and this understanding seems to be the essence of Homo sapiens. It is central to the natural history of the species. I think that the cerebral cortex, that sublime center of cleverness, of mechanistic comprehension, must be wired into the limbic lusts. That would account for the compulsion which understanding seems to be.

But life supplies infinite perceptions, and the explanations accumulate. They accumulate until they amount to a grand explanation, a grand comprehension, of how reality works. Let us call this accretion an illusion. The mind works by creating illusions of existence.

Keep in mind that I am using the term "illusion" in the broadest sense, to include any kind of comprehension: suppositions, theories, philosophies, myths, religious beliefs, and so on, for the same method of cerebration creates them all.

Now, the interesting thing about illusions is that it doesn't seem to matter whether they are absolutely right, just so long as they are right enough that life can bumble along more or less normally. Europeans once believed that the earth was flat, and people were secure in their illusions until Columbus went over the edge and came back. At various times in history people have believed that malaria is caused by bad air, that the body contains two kinds of blood, which are separate and never mix, and as recently as the late 1950s the scientific establishment itself believed that human beings contain forty-eight, not forty-six, chromosomes. Life went on.

What humans tolerate as normal ranges from the Eskimo's daily duties among the icebergs to the Hottentot's coexistence with elephants, rhinoceroses, lions, mambas, to the Westerner's addiction to televisions, computers, automobiles, fast food, unrestricted growth and development, industrial agriculture, and fossil fuel. As for forms of government, despite what we Americans might think, normal government ranges from communisms, to socialisms, to oligarchies, dictatorships, despotisms, republics, democracies, and variations and permutations of these, and life goes on, and the population of the world continues to rise. In the big scheme they are all normal states of human affairs. In other words, as long as a system of illusions stays within a remarkably permissive band of reality, you can believe almost anything and still survive.

What does matter about illusions is that enough people buy into the central ones, which creates internal consistency and allows people to cooperate as a society, as a culture. And society can function quite well, apparently, in the face of wildly false illusions. Just so long as the system of illusions operates within the wide plains of normalcy, in other words, so long as it is benignly false, allows people to muddle along, and does not cause out-and-out disaster, then it will thrive. Eventually a price must be paid. There is always a price. The society, culture, civilization will crash into reality, which is happening to us in the West at the present time with the environmental breakdown around the planet.

The fact is, most humans are not concerned with truth; they are concerned with political survival. If enough people share an illusion, they amount to an army-of votes, if not of armed personnel. Crusades occur, mass exterminations, military buildups, as do movements in art, religion, science, philosophy - all based on the passions with which people embrace

their illusions. Within each area, controversies rage and leaders fight to recruit minds for this illusion or that. This seems to be an emotional pattern that occurs in all areas of human endeavor.

And here is where, as with the tuna, the limitations of legacy overtake evolutionary refinement. The cerebral cortex sits atop the limbic system and the reptilian complex, and when all is said and decided, the rational mind serves the four F's: fleeing, fighting, feeding, etc. Evolution has used components from the monkey. This is the result.

It is compounded by the nature of mammalian learning. The ideas we learn in childhood become 'imprinted' in our minds, and the normal human is not capable of and/or not interested in discarding the beliefs and values acquired in childhood. Life is too short. There is too much to lose. There is too much anxiety, too many chances to fail in starting over.

Evolution has solved this dilemma with one of its most brilliant inventions. It is known as denial, the bodyguard of false illusion. Homo sapiens possesses an absolutely fabulous ability to deny the truth. And why not. If a man has twenty million dollars in bluechip stocks, a mountain chalet, a yacht, several wives in sequence, and various kids, he has proven his fitness in the prevailing system. He has won mates, territory, a good position on the peck order—in short, he has satisfied the demands of his limbic system and his reptilian complex. He is not about to question the illusions under which he has earned all this.

And so we come to the ultimate test of the human mind: the salvation of the environment. Can Homo sapiens survive the threat of itself? In light of its capacity for false illusion and its phenomenal capacity for denial, can it even conceive the issues?

The master switches are population growth and Western economics. There is no unified, enforceable, worldwide policy to deal with them, and they are diametrically opposed to long-term survival. Five billion people cannot help but poison the earth's physiology, because five billion mouths devour so much of the planet's biomass that the ecosystems are shorted, and five billion anuses produce so much feces that unless it is all recycled through the soil in which it originated, it accumulates in the water tables or in the offshore waters. Five billion people also desire the comfortable, easy, painless, narcotic lifestyle of the West, and that limbic desire foments Western industry. The living surface of Earth is a biological organ and cannot survive the caustic feces that industry for five billion produces. And Western economics, based on indefinite growth and driven by the self-interest of each individual, begets hysterical consumption of resources.

Yet at the present time there is no political or religious movement with the remotest chance of defeating the illusions that be. The masses of Homo sapiens deny that anything is ill with their world. Ozone holes, greenhouse effects, desertification, fouling of aquifers, erosion of soil, pesticide treadmill, extermination of fisheries, buildup of toxic and nuclear wastes, accumulation of garbage, an extinction rate equal to that caused by the last asteroid—the corporate heads and the heads of state declare they are leading us toward the light, that Mother Earth will always provide, that the gods will always intervene. Whole books are written in defense of this thesis, sophisticated books armed with the most refined

rationalizations. The illusions, I fear, will remain false until the reality crumbles.

Which brings us back to Evolution and its fondness for refining the old in pursuit of sophistication, not perfection. How sublime the human mind, how exquisite the reasoning center and the power of rationalization. How utterly flawed its essence.

For those who seek the truth, I suspect it is something like this: as Evolution attempted with the tuna, it has made a rousing attempt to lift Homo sapiens above its legacy. But try as Evolution will, the species will always be mammalian. No matter how sophisticated its 'higher' faculties become, it will always be the ultimate in the sophisticated monkey. It will never transcend the inherent limitations of its ancestral parts. In the end it finds itself performing the same kind of flawed circular fate as the tuna: Homo sapiens deceives itself because of the ancestry of its brain; because of the ancestry of its brain, Homo sapiens must deceive itself.

And what has all this to do with my cockroach memoirs? It is all context, my friends-background to illuminate what the roaches taught me in the rearing room. Evolution, despite its compulsion to refine, does stumble close to perfection from geologic time to geologic time. The cockroach is as near to perfection as Evolution has ever come.

Since the basic goal of evolution is survival, perfection would be eternal existence. By that criterion the cockroach is approaching the ultimate end; it has been around in recognizable form for at least 320 million years. The basic purpose of the brain is to aid survival. By that criterion the cockroach is divine genius, and Homo sapiens' 'which has been around for about 40 thousand years, does not appear to be a very bright creature. It is another result of Evolution's flawed character.

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It has been fifteen years now since I studied the cockroach. Like all humans who live in cities, I do on occasion run into these insects, and I must confess that whenever I do, those old lessons come to life.

I was jogging at night, several months ago, when I fell into a pots hole and broke my right ankle'' Shock set in, and not realizing the bone was fractured, I began limping to the nearest telephone booth to call home for a ride. No sooner did I set out, however, than I spotted a cat crouched on a manhole cover. Sure enough, a fat American roach came feeling its way up through the tool hole. The cat, the tip of its tail twitching, tensed and aimed. It pounced, cuffed the insect about, pinned it down, and grabbed it in its mouth.

I moved closer and saw another roach searching for food. Just for the hell of it, I shoed it toward the cat. The cat could not resist a moving roach and dropped the first to pursue the second. The first roach skittered hysterically for a few feet, slowed to a walk, and stopped still as a stone. The cat, now holding the second roach in its jaws, crouched in the street and stared suspiciously at me. I stood gingerly on one foot and stared back, the four of us fixed motionless in the blackness. Then the first roach turned back toward the manhole, the cat dropped the second roach to grab the first, and I hobbled off to get medical aid. It felt like the logical thing to do.

