

Dinomania

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by Stephen Jay Gould

Jurassic Park

directed by Steven Spielberg, screenplay by Michael Crichton, by David Koepp
Universal city studios

The Making of Jurassic Park

by Don Shay, by Jody Duncan
Ballantine, 195 pp., \$18.00 (paper)

Jurassic Park

by Michael Crichton
Ballantine, 399 pp., \$6.99 (paper)

1.

Macbeth's soliloquy on his intended murder of King Duncan provides our canonical quotation for the vital theme that deeds spawn unintended consequences in distant futures. "If it were done when 'tis done," Macbeth muses, "then 'twere well it were done quickly." The act must be swift but, even more importantly, the sequelae must be contained, as Macbeth hopes to

*trammel up the consequence, and catch
With his surcease success; that but this blow
Might be the be-all and the end-all here.*

Yet Macbeth fears that big events must unleash all the genies of unknowable futures—for "bloody instructions, which, being taught, return to plague th' inventor."

I doubt that Henry Fairfield Osborn considered these lines, or imagined any popular future for his new discoveries, when he published a conventionally dull, descriptive paper in 1924 on three genera of dinosaurs recently found in Mongolia on the famous Gobi Desert expedition. In this paper, entitled "Three New Theropoda, *Protoceratops* Zone, Central Mongolia,"¹ Osborn named, and described for the first time, the "skull and jaws, one front claw and adjoining phalanges" of a small, but apparently lithe and skillful carnivore. He called his new creature *Velociraptor mongoliensis* to honor these inferred skills, for *Velociraptor*, means "quick seizer." *Velociraptor*, Osborn wrote, "seems to have been an alert, swift-moving carnivorous dinosaur." He then describes the teeth as "perfectly adapted to the sudden seizure of...swift-moving prey.... The long rostrum and wide gape of the jaws indicate that the prey was not only living but of considerable size."

Osborn was America's greatest vertebrate paleontologist, but he was also the politically conservative, socially prominent, imperious president of the American Museum of Natural History in New York. He would, I think, have been quite surprised, and not at all amused, to learn that, nearly seventy years later, his creature would win a new, and vastly extended, status as the primary dinosaur hero (or villain, depending on your modes of rooting) in *Jurassic Park*, the biggest blockbuster film of all time.

Public fascination has always followed these prehistoric beasts. Just ten years after Richard Owen coined the word dinosaur in 1840, sculptor Waterhouse Hawkins was hard at work on a series of full-scale models to display in the Crystal Palace during the Great Exhibition of 1851. (The Palace burned down in 1936, but Hawkins's dinosaurs, recently spruced up with a coat of paint, can still be seen in Sydenham, south of London.)

But the popular acclaim of dinosaurs has been fitful and episodic. We saw them in *King Kong* (thanks to Willis O'Brien and his brilliant technique of stop-motion filming using models, later magnified). We filled our cars under the sign of the jolly green giant *Brontosaurus*, the logo of Sinclair Oil (who also provided a fine exhibit at the 1939 World's Fair in New York). But dinosaurs never became a big or truly pervasive cultural icon, and some decades largely ignored them. I was a "dinosaur nut" as a kid growing up in New York during the late Forties and early Fifties. Hardly anyone knew or cared about them, and I was viewed as a nerd and misfit on that ultimate field of vocational decision—the school playground at recess. I was called "fossil face"; the only other like-minded kid in the school became "dino" (I am pleased to report that he also became a professional natural historian). The names weren't funny, and they hurt.

During the last twenty years, however, dinosaurs have vaulted to a steady level of culturally pervasive popularity—from gentle Barney, who teaches proper values to young children on a PBS television series, to ferocious monsters who can promote films from G to R ratings. This dinosaurian flooding of popular consciousness guarantees that no paleontologist can ever face a journalist and avoid what seems to be the most pressing question of the Nineties: Why are children so fascinated with dinosaurs?

The question may be commonplace, but it remains poorly formulated by conflating two quite separate issues. The first—call it the Jungian or archetypal theme—seeks the universal reason that stirs the soul of childhood (invariably fatuous and speculative, hence my dislike of the question). To this inquiry, I know no better response than the epitome proposed by a psychologist colleague: “big, fierce, and extinct”—in other words, alluringly scary, but basically safe.

Most inquirers stop here, supposing the question resolved when they feel satisfied about archetypal fascination. But this theme cannot touch the heart of current dinomania, culminating in the extraordinary response to *Jurassic Park*, for an obvious, but oddly disregarded, reason: dinosaurs were just as big, as fierce, and as extinct forty years ago, but only a few nerdy kids, and even fewer professional paleontologists, gave a damn about them. We must therefore pose the second question: Why now and not before?

We might propose two solutions to this less general, but more resolvable, question—one that I wish were true (but almost cannot be), and one that I deeply regret (but must surely be correct). As a practicing paleontologist, I would love to believe that current dinomania arose as a direct product of our research, and of all the fascinating new ideas that our profession has generated about dinosaurs. The slow, lumbering, stupid, robotic, virtually behaviorless behemoths of my childhood have been replaced by lithe, agile, potentially warm-blooded, adequately smart, and behaviorally complex creatures. The giant sauropods were mired in ponds during my youth, for many paleontologists regarded them as too heavy to hold up their own bodies on land. Now they stride across the plains, necks and tails outstretched. In some reconstructions, they even rear up on their hind legs to reach high vegetation, or to scare off predators (they are so depicted in the first *Brachiosaurus* scene of *Jurassic Park*, and in the full-scale fiberglass model of *Barosaurus* in the rotunda of the American Museum of Natural History—though most of my colleagues consider such a posture ridiculously unlikely).

When I was a child, ornithopods laid their eggs and then walked away forever. Today, these same creatures are the very models of maternal, caring, politically correct dinosaurs. They watch over their nests, care for their young, form cooperative herds, and bear such lovely peaceful names as *Maiasauria*, the earth mother lizard (in contrast with such earlier monikers as *Pachycephalosaurus*, the thick bonehead). Even their extinction now appears in a much more interesting light. They succumbed to vaguely speculative types of “climatic change” in my youth; now we have firm evidence for extraterrestrial impact as the trigger for their final removal.

But how can this greening of dinosaurs be the major reason for present faddishness—for if we credit the Jungian theme at all, then the substrate for fascination has always been present, even in the bad old days of dumb and lumbering dinosaurs (who were still big, fierce, and extinct). What promotes this substrate to overt and pervasive dinomania? To such questions about momentary or periodic fads, one quintessentially American source usually supplies a solution—recognition and exploitation of commercial possibilities.

When I was growing up on the streets of New York City, yo-yo crazes would sweep through kiddie culture every year or two, usually lasting for a month or so. These crazes were not provoked by any technological improvement in the design of yo-yos (just as more competent dinosaurs do not engender dinomania). Similarly, a Jungian substrate rooted in control over contained circular motion will not explain why every kid needed a yo-yo in July 1951, but not in June 1950 (just as dinosaurs are always available, but only sometimes exploited).

The answer, in short, must lie in commercialization. Every few years, someone figured out how to make yo-yos sell. At some point about twenty years ago, some set of forces discovered how to turn the Jungian substrate into profits from a plethora of products. You just need a little push to kick the positive feedback machine of human herding and copying behavior into its upward spiral (especially powerful in kids with disposable income).

I’d love to know the source of the initial push (a good theme for cultural historians). Should we look to the great expansion of museum gift shops from holes-in-the-wall run by volunteers to glitzy operations crucial to the financial health of their increasingly commercialized parent institutions? Or did some particular product, or character, grip enough youthful imaginations at some point? Should we be looking for an evil genius, or just for an initial chaotic fluctuation, then amplified by cultural loops of positive feedback?

2.

Contemporary culture presents no more powerful symbol, or palpable product, of pervasive, coordinated commercialization than the annual release of “blockbuster” films for the summer viewing season. The movies themselves are sufficiently awesome, but when you consider the accompanying publicity machines, and the flood of commercial tie-ins from lunch pails to coffee mugs to T-shirts, the effort looks more like a military blitzkrieg than an offer of entertainment. Therefore every American who is not mired in some Paleozoic pit surely knows that dinomania has reached its apogee with the release of Steven Spielberg’s film version of Michael Crichton’s novel *Jurassic Park*. As a paleontologist, I could not possibly feel more ambivalent about the result—marveling and cursing, laughing and moaning. One can hardly pay greater tribute to the importance of an event than to proclaim the impossibility of neutrality before it.

John Hammond (an entrepreneur with more than a touch of evil in the book, but kindly and merely overenthusiastic in the film) has built the ultimate theme park (for greedy profits in the book, for mixed but largely honorable motives in the film) by remaking living dinosaurs out of DNA extracted from dinosaur blood preserved within mosquitoes and other biting insects entombed in fossil Mesozoic amber. Crichton deserves high praise for developing the most clever and realistic of all scenarios for such an impossible event, for such plausibility is the essence of science fiction at its best. (The idea, as Crichton acknowledged, had been kicking around paleontological labs for quite some time.)

Until a few months ago, the record for oldest extracted DNA belonged to a twenty-million-year-old magnolia leaf from Idaho.² A group of my colleagues managed to recover nearly the entire sequence—1320 of 1431 base pairs—of a chloroplast gene prominently involved in photosynthesis. (Most DNA lies in chromosomes of the nucleus, but mitochondria—energy factories—and chloroplasts—sites of photosynthesis in plants—also contain small DNA programs.)

But amber has also been yielding results during the past year. In the September 25, 1991, issue of *Science* a group of colleagues reported the successful extraction of several DNA fragments (fewer than two hundred base pairs each) from a 25–30-million-year-old termite encased in amber.³ Then, in a publishing event tied to the opening of *Jurassic Park*, the June 10, 1993, issue of the leading British journal *Nature*—same week as the film's premiere—reported results of another group of colleagues on the extraction of two slightly larger fragments (315 and 226 base pairs) from a fossil weevil.⁴ The amber enclosing this insect is 120–135 million years old—not quite as ancient as Jurassic, but from the next geological period, called Cretaceous, when dinosaurs were also dominant creatures of the land (most of the *Jurassic Park* dinosaurs are Cretaceous in any case).⁵

The nearly complete blurring of pop and professional domains represents one of the most interesting by-products—a basically positive one in my view—of the *Jurassic Park* phenomenon. When a staid and distinguished British journal uses the premiere of an American film to set the sequencing of its own articles, then we have reached an ultimate integration. Museum shops sell the most revolting dinosaur kitsch. Movies employ the best paleontologists as advisers to heighten the realism of their creatures. Orwell's pigs have become human surrogates walking on two legs—and “already it was impossible to say which was which” (nor do I know anymore who was the pig, and who the person, at the outset—that is, if either category be appropriate).

If all this welcome scientific activity gives people the idea that dinosaurs might actually be re-created by Crichton's narrative, I hasten (with regret) to pour frigid water upon this greatest reverie of any aficionado of past life. Aristotle wisely taught us that one swallow doesn't make a summer—nor, his modern acolytes might add, does one gene (or just a fragment thereof) make an organism. Only the most prominent, easily extracted, or multiply copied bits of fossil DNA have sequenced—and we have no reason to believe that anything approaching the complete genetic program of an organism has been preserved in such ancient rocks. (The magnolia study, for example, found no nuclear DNA at all, while the recovered chloroplast gene occurs in numerous copies per cell, with a correspondingly better chance of preservation. More than 90 percent of the attempts yielded no DNA at all. The amber DNA is nuclear, but represents fragments of coding for the so-called 16S and 18S ribosomal RNA genes—among the most commonly and easily recovered segments of the genetic program.)

DNA is not a geological stable compound. We may recover fragments, or even a whole gene, here and there, but to wizardry can make an organism from just a few percent of its codes. *Jurassic Park* honorably acknowledged this limitation by having their genetic engineers use modern frog DNA to fill in the missing spaces in their dinosaur programs. But in so doing, they commit their worst scientific blunder—the only one that merits censure as a deep philosophical error, rather than a studied superficial mistake consciously permitted to bolster the drama of science fiction.

An amalgamated code of, say, 50 percent dinosaur DNA and 50 percent frog DNA would never foster the embryological development of a functioning organism. This form of reductionism is simply silly. An animal is an integrated entity, not the summation of its genes, one by one. Fifty percent of your genetic code doesn't make a perfectly good half of you; it makes no functioning organism at all. Genetic engineers might get by with a missing dab or two, but large holes cannot be plugged with DNA from a different zoological class (frogs are amphibians, dinosaurs are reptiles, and their lines diverged in the Carboniferous Period, more than 100 million years before the origin of dinosaurs). The embryological decoding of a DNA program into an organism represents nature's most complex orchestration. You need all the proper instruments and conductors of an evolutionarily unique symphony. You cannot throw in half a rock band playing its own tunes by its own rules and hope for harmony.

When a scientist soberly states that something cannot be done, the public has every right to express doubts based on numerous historical precedents for results proclaimed impossible, but later both achieved and far surpassed. But the implausibility of reconstructing dinosaurs by the amber scenario resides in a different category of stronger argument.

Most proclamations of impossibility only illustrate a scientist's lack of imagination about future discovery—impossible to see the moon's backside because you can't fly there, impossible to see an atom because light microscopy cannot resolve such dimensions. The object was always there: atoms and the moon's far side. We only lacked a technology that was possible in principle to attain, but unimagined in practice.

But when we say that a particular historical item—like a dinosaur species—can't be recovered, we are invoking a different and truly ineluctable brand of impossibility. If all information about a historical event has been lost, then it just isn't there anymore and the event cannot be reconstructed. We are not lacking a

technology to see something that actually exists; rather, we have lost all information about the thing itself, and no technology can recover an item from the void. Suppose I want to know the name of every soldier who fought in the Battle of Marathon. The records, I suspect, simply don't exist—never, nowhere, and nohow. No future technology, no matter how sophisticated, can recover events with crucially missing information. So it is, I fear, with dinosaur DNA. We may make gene machines more powerful by orders of magnitude than anything we can now even conceive. But if full programs of dinosaur DNA exist nowhere—and we can find only the scrap of a gene here and there—then we have permanently lost these particular items of history.

3.

I liked the book version of *Jurassic Park*. In addition to using the best possible scenario for making dinosaurs, Crichton based the book's plot upon an interesting invocation of currently fashionable chaos theory. To allay the fears of his creditors, John Hammond brings a set of experts to Jurassic Park, hoping to win their endorsement. His blue ribbon panel includes two paleontologists and a preachy iconoclast of a mathematician named Ian Malcolm—the novel's intellectual and philosophical center. Malcolm urges—often, colorfully, and at length—a single devastating critique based on his knowledge of chaos and fractals: the park's safety system must collapse because it is too precariously complex in its coordination of so many, and so intricate, fail-safe devices. Moreover, the park must fail both unpredictably and spectacularly—and does it ever! Malcolm explains,

It's chaos theory. But I notice nobody is willing to listen to the consequences of the mathematics. Because they imply very large consequences for human life. Much larger than Heisenberg's principle or Gödel's theorem, which everybody rattles on about.... But chaos theory concerns everyday life.... I gave all this information to Hammond long before he broke ground on this place. You're going to engineer a bunch of prehistoric animals and set them on an island? Fine. A lovely dream. Charming. But it won't go as planned. It is inherently unpredictable.

We have soothed ourselves into imagining sudden change as something that happens outside the normal order of things. An accident, like a car crash. Or beyond our control, like a fatal illness. We do not conceive a sudden, radical, irrational change as built into the very fabric of existence. Yet it is. And chaos theory teaches us....

Moreover, Malcolm uses this argument—not the usual and romantic pap about “man treading where God never intended” (to invoke the old language as well as the old cliché)—to urge our self-restraint before such scientific power:

And now chaos theory proves that unpredictability is built into our daily lives. It is as mundane as the rainstorm we cannot predict. And so the grand vision of science, hundreds of years old—the dream of total control—had died, in our century.

This reliance on chaos as a central theme did, however, throw the book's entire story line into a theoretically fatal inconsistency—one that, to my surprise, no reviewer seemed to catch at the time. The book's second half is, basically, a grand old, rip-roaring chase novel, with survivors managing (and with nary a scratch to boot) to prevail through a long sequence of independent and excruciatingly dangerous encounters with dinosaurs. By the same argument that complex sequences cannot proceed as planned—that is, in this case, toward the novelistic necessity of at least some characters surviving—not a human soul in the park should have stood a chance of proceeding harmless through such a sequence. Malcolm even says so: “Do you have any idea how unlikely it is that you, or any of us, will get off this island alive?” But I'm willing to accept the literary convention for bending nature's laws in this case.

I expected to like the film even more. The boy dinosaur nut still dwells within me, and I have seen them all, from *King Kong* to *One Million Years B.C.*, to *Godzilla*. The combination of a better story line, with such vast improvement in monster-making technology, and all done by the most masterly hands in the world, seemed to guarantee success at a spectacular new level of achievement. I did not feel that I wasted my two hours or my seven bucks (plus another two for the indigestible “raptor bites” candy tie-in), but I was deeply disappointed by much about the movie.

The dinosaurs themselves certainly delivered. As a practicing paleontologist, I confess to wry amusement at the roman-à-cleffery embedded in the reconstructions. I could recognize nearly every provocative or *outré* idea of my colleagues, every social tie-in now exploited by dinosaurs in their commanding role as cultural icons. The herbivores are so sweet and idyllic. The giant brachiosaurs low to each other like cattle in the peaceable kingdom. They rear up on their hind legs to find the juiciest leaves. The smaller species care for and help each other—down to such subtle details as experienced elders keeping young *Gallimimus* in the safer center of the fleeing herd.

Even the carnivores are postmodernists of another type. The big old fearsome standard, *Tyrannosaurus rex*, presides over Jurassic Park in all her glory (and in her currently fashionable posture, with head down, tail up, and vertebral column nearly parallel to the ground). But the mantle of carnivorous heroism has clearly passed to the much smaller *Velociraptor*, Henry Fairfield Osborn's Mongolian jewel. Downsizing and diversity are in; constrained hugeness has become a tragic flaw. *Velociraptor* is everything that modern corporate life values in a tough competitor—mean, lean, lithe, and intelligent. They hunt in packs, using a fine military technique of feinting by one beast in front, followed by attack from the side by a co-conspirator. In the film's best moment of wry parody of its own inventions, the wonderfully stereotyped stiff-upper-lip-British-hunter Muldoon gets the center beast in his gun's sight, only to realize too late that the side-hunting companion is a few inches from his head. He looks at the side beast, says “Clever girl” in a

tone of true admiration (all of Jurassic Park's dinosaurs are engineered to be female in another ultimately failed attempt to control their reproduction), and then gets gobbled to death.

Even so, Spielberg didn't choose to challenge pop culture's canonical dinosaurs in all details of accuracy and professional speculation; blockbusters must, to some extent, play upon familiarity. Ironically, he found the true size of *Velociraptor*—some six feet in length—too small for the scary effects desired, and enlarged them to nearly ten feet, thus moving partway back toward the old stereotype, otherwise so effectively challenged. He experimented, in early plans and models, with bright colors favored by some of my colleagues on the argument that bird-like behavior (and closeness to bird ancestry) might imply avian styles of coloration for the smaller dinosaurs (the original *Velociraptor* models were tiger striped). But he eventually opted for conventional reptilian dullness (“Your same old, ordinary, dinosaur shit-green,” lamented one of my graduate students).

But let me not carp. The dinosaur scenes are spectacular. Intellectuals too often either pay no attention to such technical wizardry or, even worse, actually disdain special effects with such dismissive epithets as “merely mechanical.” I find such small-minded parochialism outrageous. Nothing can be more complex than a living organism, with all the fractal geometry of its form and behavior (compared with the almost childish simple lines of our buildings, and of almost anything else in the realm of human construction).⁶ The use of technology to render accurate and believable animals therefore becomes one of the greatest all-time challenges to human ingenuity.

The field has a long and honorable history of continually improving techniques—and who would dare deny this story a place in the annals of human intellectual achievement. An old debate among historians of science asks whether most key technological inventions arise from practical need (more often in war than in any other activity), or from opportunities to fool around during periods of maximal freedom from practical pressures. My friend Cyril Smith, the wisest scientist-humanist I ever knew, strongly advocated the centrality of “play domains” as the major field for innovations with immense practical utility down the road. (He argued that block-and-tackle was invented, or at least substantially improved, in order to lift animals from underground storage pits to the game floor of the Roman Colosseum.) Yes, *Jurassic Park* is “just” a movie—but for this very reason, it had freedom (and money) to develop techniques of reconstruction, particularly computer generation or CG, to new heights of astonishing realism. And yes, it matters—for immediately aesthetic reasons, and for all manner of practical possibilities in the future.

Spielberg originally felt that computer generation had not yet progressed far enough, and that he would have to do all his dinosaur scenes with the fascinating array of modeling techniques long used, but constantly improving, in Hollywood—stop-motion with small models, people dressed in dinosaur suits, puppetry of various sorts, robotics with hydraulic apparatus moved by people sitting at consoles. (All this is described clearly, if uncritically, in *The Making of Jurassic Park*, the formula-book by Don Shay and Jody Duncan—just one of the innumerable commercial tie-ins generated by all blockbusters, but a worthy effort in this case.)

But computer generation improved spectacularly during the two-year gestation of *Jurassic Park*, and dinosaurs are entirely machine-constructed in some of the most spectacular scenes—meaning, of course, that performers interacted with empty space during the actual shooting. (Cartoons have been computer-generated for many years, but remember the entirely different problem that Spielberg faced. Roger Rabbit was supposed to be a “toon”; the computer-generated dinosaurs of *Jurassic Park* must be indistinguishable from real beasts.) I learned, after watching the film, that my two favorite dinosaur scenes—the fleeing herd of *Gallimimus*, and the final attack of *Tyrannosaurus* upon the last two *Velociraptors*—were entirely computer-generated.

The effect does not always work. The very first dinosaur scene—when paleontologist Grant hops out of his vehicle to encounter a computer-generated *Brachiosaurus*—is the film's worst flop. Grant is clearly not in the same space as the dinosaur, and I could only think of Victor Mature, similarly out of synch with his beasts, in *One Million Years B.C.*

The dinosaurs are wonderful, but they aren't on the set enough of the time (yes, I know how much more they cost than human actors). Unfortunately, the plot line for the human actors reduces to pap and romantic drivel of the worst kind, the very antithesis of the book's grappling with serious themes. It is so ironic, but I fear that mammon and the perception (false I hope) of the need to dumbdown for mass audiences have brought us to this impasse of utter inconsistency. How cruel, how perverse, that we invest the most awesome expertise (and millions of bucks) in the dinosaurs, sparing no knowledge or expense to render every detail, every possible nuance, in the most accurate and realistic way. I have nothing but praise for the thought and care, the months and years that went into each dinosaur model, the pushing of computer generation to a new world of utility, the concern for rendering every detail with consummate care, even the tiny bits that few will see and the little sounds that fewer will hear. I think of medieval sculptors who lavished all their skills upon invisible statues on the parapets, for God's view is best (internal satisfaction based on personal excellence in modern translation). How perverse that we permit a movie to do all this so superbly well, and then throw away the story because we think that the public will reject, or fail to comprehend, any complexity beyond a Neanderthal “duh” or a brontosaurian bellow. I just don't believe it.

We feel this loss most in the reconstruction of the mathematician Ian Malcolm as the antithesis of his character in the book. He still presents himself as a devotee of chaos theory (“a chaotician”), but he no longer uses its argument (as previously documented in this article) to formulate his criticism of the park. Instead, he is given the oldest diatribe, the most hackneyed and predictable staple of every Hollywood monster film since *Frankenstein*: man (again I prefer the old gender-biased term for such an archaic line) must not disturb the proper and given course of nature; man must not tinker in God's realm. What dullness

and disappointment (and Malcolm, in the film, is a frightful and tendentious bore, obviously so recognized by Spielberg, for he effectively puts Malcolm out of action with a broken leg about halfway through).

Not only have we heard this silly argument a hundred times before (can Spielberg really believe that his public could comprehend no other reason for criticizing a dinosaur park?), but its formulation by Malcolm utterly negates his proclaimed persona as a theoretician of chaos. In the film's irony of ironies, Malcolm's argument becomes the precise antithesis of chaos theory and also relies on whopping inconsistency to boot. Consider these two flubs that make the story line completely incoherent.

1. As Malcolm rails against genetic reconstruction of lost organisms, Hammond asks him if he would really hesitate to bring the California condor back to life (from preserved DNA) should the last actual bird die. Malcolm answers that he would not object, and would view such an act as benevolent, because the condor's death would have been an accident based on human malfeasance, not an expression of nature's proper course. But we must not bring back dinosaurs because they disappeared along a natural and intended route: "Dinosaurs," he says, "had their shot, and nature selected them for extinction." But such an implied scenario of groups emerging, flourishing, and dying, one after the other in an intended and predictable course, is the antithesis of chaos theory and its crucial emphasis on the great accumulating effect of apparently insignificant perturbations, and on the basic unpredictability of long historical sequences. How can a chaotician talk about nature's proper course at all?
2. If "nature selected them for extinction," and if later mammals therefore represent such an improvement, why can the dinosaurs of Jurassic Park beat any mammal in the place, including the most arrogant primate of them all. You can't have it both ways. If you take dinosaur revisionism seriously, and portray them as smart and capable creatures able to hold their own with mammals, then you can't argue against reviving them by claiming that their extinction was both predictable and appointed as life ratcheted onward to greater complexity.

Since Malcolm actually preaches the opposite of chaos theory, but presents himself as a chaotician and must therefore talk about it, the film's material on chaos is reduced to an irrelevant caricature in the most embarrassing of all scenes—Malcolm's half-hearted courting of the female paleontologist (before he learns of her partnership with the male paleontologist), by grasping her hand, dripping water on the top and using chaos theory to explain why we can't tell which side the drop will run down! How are the mighty fallen.

4.

In the film, John Hammond flies his helicopter to a site in Montana, under excavation by Ellie Sattler and Alan Grant, the two paleontologists chosen to "sign off" on his park and satisfy his investors. They say at first that they cannot come, for they are hard at work on the crucial phase of collecting a fossil *Velociraptor*. Hammond promises to support their research for three years if they will spend one weekend at his site. Grant and Sattler suddenly realize that they would rather be no place else on earth; the *Velociraptor* can wait (little do they know...).

This scene epitomizes the ambivalence that I feel about the *Jurassic Park* phenomenon, and about dinomania in general. Natural history is, and has always been, a beggar's game. Our work as natural historians has never been funded by or for itself. We have always depended upon patrons, and upon other people's perceptions of the utility of our data. We sucked up to princes who wanted to stock their baroque *Wunderkammern* with the most exotic specimens. We sailed on colonial vessels for nations that viewed the cataloguing of faunas and floras as one aspect of control (we helped Bligh bring breadfruit from Tahiti to feed slaves in the West Indies). Many, but not all, of these partnerships, have been honorable from our point of view, but we have never had the upper hand. Quite the contrary, our hand has always been out.

Few positions are more precarious than that of the little guy in associations based on such unequal sizes and distributions of might. The power brokers need our expertise, but we are so little in comparison, so quickly bedazzled, and often silenced, by promises (three years as a lifetime's dream for the paleontologists and an insignificant tax write-off for Hammond), so easily swallowed up—if we do not insist on maintaining our island of intact values and concerns in the midst of such a different, and giant, operation. How shall we sing the Lord's song in a strange land?

I do not blame the prince, the captain, or his modern counterparts: the government grantor, the commercial licensor, or the blockbuster filmmaker. These folks know what they want, and they are usually upfront about their needs and bargains. It is our job to stay whole, not be swallowed in compromise, not to execute a pact of silence, or endorsement, for proffered payoff. The issue is more structural than ethical: we are small, though our ideas may be powerful. If we merge, we are lost.

Mass commercial culture is engulfing, vastly bigger than we can ever be. Mass culture forces compromises, even for the likes of Steven Spielberg. He is given the resources to prepare and film his magnificent special effects; but I cannot believe that he feels comfortable about ballyhooing all the ridiculous kitsch now for sale under the coordinated marketing program of movie tie-ins (from fries in a dinosaur's mouth at McDonald's—sold to kids too young for the movie's scary scenes—to a rush on amber rings at fancy jewelry stores); and I cannot imagine that either he or Michael Crichton is truly satisfied with their gutless and incoherent script as an enjoined substitute for an interesting book. Imagine, then, what compromises the same commercial world forces upon the tiny principality of paleontological research?

As a symbol of our dilemma, consider the plight of natural history museums in the light of commercial dinomania. In the past decade, nearly every major or minor natural history museum has succumbed (not always unwisely) to two great commercial temptations: to sell many scientifically worthless, and often

frivolous, or even degrading, dinosaur products in their gift shops; and to mount, at high and separate admissions charges, special exhibits of colorful robotic dinosaurs that move and growl but (so far as I have ever been able to judge) teach nothing of scientific value about these animals. Such exhibits could be wonderful educational aids, if properly labeled and integrated with more traditional material; but I have never seen these robots presented for much more than their colors and sound effects (the two aspects of dinosaurs that must, for obvious reasons, remain most in the realm of speculation).

If you ask my colleagues in museum administration why they have permitted such incursions into their precious and limited spaces, they will reply that these robotic displays bring large crowds into the museum, mostly of people who otherwise would never come. These folks can then be led or cajoled into viewing the regular exhibits, and the museum's primary mission of science education receives a giant boost.

I cannot fault the logic of this argument, but I fear that my colleagues are expressing a wish or a hope, not an actual result, and not even an outcome actively pursued by most museums. If the glitzy displays were dispersed among teaching exhibits, if they were used as a springboard for educational programs (sometimes they are), then a proper balance of mammon and learning might be reached. But, too often, the glitz occupies a separate wing (where the higher admission charges can be monitored), and the real result gets measured in increased body counts and profits.

One major museum geared all its fancy fund-raising apparatus for years to the endowment of a new wing—and then filled it with a huge gift shop, a fancy restaurant, and an Omnimax theater, thus relegating the regular exhibits to neglect and disrepair. Another museum intended the dinosaur robots as a come-on to guide visitors to the permanent exhibits. But they found that the robots wouldn't fit into the regular museum. Did they cancel the show? Not at all. They moved it to another building on the extreme opposite end of campus—and even fewer people visited the regular museum as a result.

I may epitomize my argument in the following way: institutions have central purposes that define their integrity and being. *Dinomania* dramatizes a conflict between institutions with disparate purposes—museums and theme parks. Museums exist to display authentic objects of nature and culture—yes, they must teach; and yes, they may certainly include all manner of computer graphics and other virtual displays to aid in this worthy effort; but they must remain wed to authenticity. Theme parks are gala places of entertainment, committed to using the best displays and devices from the increasingly sophisticated arsenals of virtual reality to titillate, to scare, to thrill, even to teach.

I happen to love theme parks, so I do not speak from a rarefied academic post in a dusty museum office. But theme parks are, in many ways, the antithesis of museums. If each institution respects the other's essence and place, this opposition poses no problem. But theme parks belong to the realm of commerce, museums to the world of education—and the first is so much bigger than the second. Commerce will swallow museums if educators try to copy the norms of business for immediate financial reward.

Speaking about the economics of major sporting events, Mr. Steinbrenner once opined that "it's all about getting the fannies into the seats." If we have no other aim than to stuff more bodies in, and to extract more dollars per fanny, then we might as well convert our museums to theme parks and fill the gift shops with coffee mugs. But then we will be truly lost—necessarily smaller and not as oomphy as Disneyland or Jurassic Park, but endowed with no defining integrity of our own.

Our task is hopeless if museums, in following their essences and respecting authenticity, condemn themselves to marginality, insolvency, and empty corridors. But, fortunately, this need not and should not be our fate. We have an absolutely wonderful product to flog—real objects of nature. We may never get as many fannies as *Jurassic Park*, but we can and do attract multitudes for the right reasons. Luckily, and I do not pretend to understand why, authenticity stirs the human soul (and attracts fannies aplenty). The appeal is cerebral and entirely conceptual, not at all visual.

Casts and replicas are now sufficiently like the originals that no one but the most seasoned expert can possibly tell the difference. But a cast of the Rosetta stone is plaster (however intriguing and informative), while the object itself, on display in the British Museum, is magic. A fiberglass *Tyrannosaurus* merits a good look; the real bones send shivers down my spine as I think of the animal that bore them some 70 million years ago. Even the wily John Hammond knew this principle and awarded museums their garland of ultimate respect. He wanted to build the greatest theme park in the history of the world—but he could do so only by abandoning the virtual reality of most models, and stocking his own park with real, living dinosaurs, reconstructed from authentic dinosaur DNA. (The conscious ironies and recursions embedded in *Jurassic Park's* own reality are clear enough—for the best dinosaurs are computer-generated within a movie based on a novel.)

For paleontologists, *Jurassic Park* is both our greatest opportunity and our most oppressive incubus—a spur for unparalleled general interest in our subject, and the source of a commercial flood that may truly extinguish dinosaurs by turning them from sources of awe into clichés and commodities. Will we have strength to stand up in this deluge? Preliminary signs are not encouraging.

New York's Museum of Natural History—where Osborn once presided; where he first described *Velociraptor*; where his bust still proclaims, "For him the dry bones came to life and giant forms of ages past rejoined the pageant of the living"—has just mounted a special exhibit (June 11—September 12, 1993) called "The Dinosaurs of Jurassic Park," commanding an additional entrance fee of \$5.00 for adults and \$2.50 for children. In its advertisement (*The New York Times*, June 13), the museum proclaims: "This one-of-a-kind exhibition features spectacular life-size dinosaurs, realistic special effects, and props from the movie, alongside actual dinosaur fossils from the Museum." Do they not see that they have inverted the

proper order—and that we will ultimately lose if authentic fossils are not primary, and cultural artifacts derivative?

But we do have one powerful advantage, if we cleave to our purpose as purveyors of authenticity. Commercial dinosaurs may dominate the moment, but must be ephemeral, for they have no support beyond their immediate profitability. Macbeth, in his soliloquy, recognized a special problem facing his plans, for he could formulate no justification beyond personal advantage:

*I have no spur
To prick the sides of my intent, but only
Vaulting ambition, which o'er-leaps itself.*

This too shall pass, and nothing of human manufacture can possibly challenge the staying power of real dinosaur bones—sixty-five million years (at least) in the making.

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1. *American Museum Novitates*, No. 144 (November 7, 1924). ↵
 2. S.J. Gould, "Magnolias from Moscow," *Natural History*, September 1992; P.S. Soltis, D. E. Soltis, and C. J. Smiley, "An rbcL sequence from a Miocene *Taxodium*," *Proceedings of the National Academy of Sciences*, January 1992, pp. 449–451. ↵
 3. R. De Salle, J. Gatesy, W. Wheeler, and D. Grimaldi, "DNA sequences from a fossil termite in Oligo-Miocene amber and their phylogenetic implications," *Science*, Volume 257 (September 25, 1992), pp. 1933–1936. ↵
 4. R. J. Cano, H. N. Poinar, N. J. Pieniazek, A. Acra, and G. O. Poinar, "Amplification and sequencing of DNA from a 120–135 million year old weevil," *Nature*, Volume 363 (June 10, 1993), pp. 536–538. ↵
 5. Pardon some trivial professional carping, but only two of the dinosaurs featured in the film version of *Jurassic Park* actually lived during the Jurassic period—the giant sauropod *Brachiosaurus*, and the small *Dilophosaurus*. All the others come from the subsequent Cretaceous period—a perfectly acceptable mixing given the film's premise that amber of any appropriate age might be scanned for dinosaur blood. Still, the majority might rule in matters of naming, though I suppose that Cretaceous Park just doesn't have the same ring. When I met Michael Crichton (long before the film's completion), I had to ask him the small-minded professional's question: "Why did you place a Cretaceous dinosaur on the cover of *Jurassic Park*?" (for the book's dust jacket—and now the film's logo—features a Cretaceous *Tyrannosaurus rex*). I was delighted with his genuine response: "Oh, my God, I never thought of that. We were just fooling around with different cover designs, and this one looked best." Fair enough; he took the issue seriously, and I would ask no more. ↵
 6. My colleague Rhonda Shearer pointed out to me that *Jurassic Park* can be interpreted in the context of socially changing views about geometry. On the contrast between complex nature and Euclidian geometry, see Rhonda Roland Shearer, "Chaos theory and fractal geometry: their potential impact on the future of art," *Leonardo*, Volume 25 (1992), pp. 143–152. ↵