

ONE
THE PLANT
Corn's Conquest

1. A NATURALIST IN THE SUPERMARKET

Air-conditioned, odorless, illuminated by buzzing fluorescent tubes, the American supermarket doesn't present itself as having very much to do with Nature. And yet what is this place if not a landscape (man-made, it's true) teeming with plants and animals?

I'm not just talking about the produce section or the meat counter, either—the supermarket's flora and fauna. Ecologically speaking, these are this landscape's most legible zones, the places where it doesn't take a field guide to identify the resident species. Over there's your eggplant, onion, potato, and leek; here your apple, banana, and orange. Spritzed with morning dew every few minutes, Produce is the only corner of the supermarket where we're apt to think "Ah, yes, the bounty of Nature!" Which probably explains why such a garden of fruits and vegetables (sometimes flowers, too) is what usually greets the shopper coming through the automatic doors.

Keep rolling, back to the mirrored rear wall behind which the butch-

ers toil, and you encounter a set of species only slightly harder to identify—there's chicken and turkey, lamb and cow and pig. Though in Meat the creaturely character of the species on display does seem to be fading, as the cows and pigs increasingly come subdivided into boneless and bloodless geometrical cuts. In recent years some of this supermarket euphemism has seeped into Produce, where you'll now find formerly soil-encrusted potatoes cubed pristine white, and "baby" carrots machine-lathed into neatly tapered torpedoes. But in general here in flora and fauna you don't need to be a naturalist, much less a food scientist, to know what species you're tossing into your cart.

Venture farther, though, and you come to regions of the supermarket where the very notion of species seems increasingly obscure: the canyons of breakfast cereals and condiments; the freezer cases stacked with "home meal replacements" and bagged platonic peas; the broad expanses of soft drinks and towering cliffs of snacks; the unclassifiable Pop-Tarts and Lunchables; the frankly synthetic coffee whiteners and the Linnaeus-defying Twinkie. Plants? Animals?! Though it might not always seem that way, even the deathless Twinkie is constructed out of . . . well, precisely what I don't know offhand, but ultimately some sort of formerly living creature, i.e., a *species*. We haven't yet begun to synthesize our foods from petroleum, at least not directly.

If you do manage to regard the supermarket through the eyes of a naturalist, your first impression is apt to be of its astounding biodiversity. Look how many different plants and animals (and fungi) are represented on this single acre of land! What forest or prairie could hope to match it? There must be a hundred different species in the produce section alone, a handful more in the meat counter. And this diversity appears only to be increasing: When I was a kid, you never saw radicchio in the produce section, or a half dozen different kinds of mushrooms, or kiwis and passion fruit and durians and mangoes. Indeed, in the last few years a whole catalog of exotic species from the tropics has colonized, and considerably enlivened, the produce department. Over in fauna, on a good day you're apt to find—beyond beef—ostrich and quail and even bison, while in Fish you can catch not just salmon and

shrimp but catfish and tilapia, too. Naturalists regard biodiversity as a measure of a landscape's health, and the modern supermarket's devotion to variety and choice would seem to reflect, perhaps even promote, precisely that sort of ecological vigor.

Except for the salt and a handful of synthetic food additives, every edible item in the supermarket is a link in a food chain that begins with a particular plant growing in a specific patch of soil (or, more seldom, stretch of sea) somewhere on earth. Sometimes, as in the produce section, that chain is fairly short and easy to follow: As the netted bag says, this potato was grown in Idaho, that onion came from a farm in Texas. Move over to Meat, though, and the chain grows longer and less comprehensible: The label doesn't mention that that rib-eye steak came from a steer born in South Dakota and fattened in a Kansas feedlot on grain grown in Iowa. Once you get into the processed foods you have to be a fairly determined ecological detective to follow the intricate and increasingly obscure lines of connection linking the Twinkie, or the nondairy creamer, to a plant growing in the earth someplace, but it can be done.

So what exactly would an ecological detective set loose in an American supermarket discover, were he to trace the items in his shopping cart all the way back to the soil? The notion began to occupy me a few years ago, after I realized that the straightforward question "What should I eat?" could no longer be answered without first addressing two other even more straightforward questions: "What am I eating? And where in the world did it come from?" Not very long ago an eater didn't need a journalist to answer these questions. The fact that today one so often does suggests a pretty good start on a working definition of industrial food: Any food whose provenance is so complex or obscure that it requires expert help to ascertain.

When I started trying to follow the industrial food chain—the one that now feeds most of us most of the time and typically culminates either in a supermarket or fast-food meal—I expected that my investigations would lead me to a wide variety of places. And though my journeys did take me to a great many states, and covered a great many

miles, at the very end of these food chains (which is to say, at the very beginning), I invariably found myself in almost exactly the same place: a farm field in the American Corn Belt. The great edifice of variety and choice that is an American supermarket turns out to rest on a remarkably narrow biological foundation comprised of a tiny group of plants that is dominated by a single species: *Zea mays*, the giant tropical grass most Americans know as corn.

Corn is what feeds the steer that becomes the steak. Corn feeds the chicken and the pig, the turkey and the lamb, the catfish and the tilapia and, increasingly, even the salmon, a carnivore by nature that the fish farmers are reengineering to tolerate corn. The eggs are made of corn. The milk and cheese and yogurt, which once came from dairy cows that grazed on grass, now typically come from Holsteins that spend their working lives indoors tethered to machines, eating corn.

Head over to the processed foods and you find ever more intricate manifestations of corn. A chicken nugget, for example, piles corn upon corn: what chicken it contains consists of corn, of course, but so do most of a nugget's other constituents, including the modified corn starch that glues the thing together, the corn flour in the batter that coats it, and the corn oil in which it gets fried. Much less obviously, the leavenings and lecithin, the mono-, di-, and triglycerides, the attractive golden coloring, and even the citric acid that keeps the nugget "fresh" can all be derived from corn.

To wash down your chicken nuggets with virtually any soft drink in the supermarket is to have some corn with your corn. Since the 1980s virtually all the sodas and most of the fruit drinks sold in the supermarket have been sweetened with high-fructose corn syrup (HFCS)—after water, corn sweetener is their principal ingredient. Grab a beer for your beverage instead and you'd still be drinking corn, in the form of alcohol fermented from glucose refined from corn. Read the ingredients on the label of any processed food and, provided you know the chemical names it travels under, corn is what you will find. For modified or unmodified starch, for glucose syrup and maltodextrin, for crystalline fructose and ascorbic acid, for lecithin and dextrose, lactic acid and ly-

sine, for maltose and HFCS, for MSG and polyols, for the caramel color and xanthan gum, read: corn. Corn is in the coffee whitener and Cheez Whiz, the frozen yogurt and TV dinner, the canned fruit and ketchup and candies, the soups and snacks and cake mixes, the frosting and gravy and frozen waffles, the syrups and hot sauces, the mayonnaise and mustard, the hot dogs and the bologna, the margarine and shortening, the salad dressings and the relishes and even the vitamins. (Yes, it's in the Twinkie, too.) There are some forty-five thousand items in the average American supermarket and more than a quarter of them now contain corn. This goes for the nonfood items as well—everything from the toothpaste and cosmetics to the disposable diapers, trash bags, cleansers, charcoal briquettes, matches, and batteries, right down to the shine on the cover of the magazine that catches your eye by the checkout: corn. Even in Produce on a day when there's ostensibly no corn for sale you'll nevertheless find plenty of corn: in the vegetable wax that gives the cucumbers their sheen, in the pesticide responsible for the produce's perfection, even in the coating on the cardboard it was shipped in. Indeed, the supermarket itself—the wallboard and joint compound, the linoleum and fiberglass and adhesives out of which the building itself has been built—is in no small measure a manifestation of corn.

And us?

2. CORN WALKING

Descendents of the Maya living in Mexico still sometimes refer to themselves as "the corn people." The phrase is not intended as metaphor. Rather, it's meant to acknowledge their abiding dependence on this miraculous grass, the staple of their diet for almost nine thousand years. Forty percent of the calories a Mexican eats in a day comes directly from corn, most of it in the form of tortillas. So when a Mexican says "I am maize" or "corn walking," it is simply a statement of fact: The very substance of the Mexican's body is to a considerable extent a manifestation of this plant.

For an American like me, growing up linked to a very different food chain, yet one that is also rooted in a field of corn, not to think of himself as a corn person suggests either a failure of imagination or a triumph of capitalism. Or perhaps a little of both. It does take some imagination to recognize the ear of corn in the Coke bottle or the Big Mac. At the same time, the food industry has done a good job of persuading us that the forty-five thousand different items or SKUs (stock keeping units) in the supermarket—seventeen thousand new ones every year—represent genuine variety rather than so many clever rearrangements of molecules extracted from the same plant.

You are what you eat, it's often said, and if this is true, then what we mostly are is corn—or, more precisely, processed corn. This proposition is susceptible to scientific proof: The same scientists who glean the composition of ancient diets from mummified human remains can do the same for you or me, using a snip of hair or fingernail. The science works by identifying stable isotopes of carbon in human tissue that bear the signatures, in effect, of the different types of plants that originally took them from the air and introduced them into the food chain. The intricacies of this process are worth following, since they go some distance toward explaining how corn could have conquered our diet and, in turn, more of the earth's surface than virtually any other domesticated species, our own included.

After water, carbon is the most common element in our bodies—indeed, in all living things on earth. We earthlings are, as they say, a carbon life form. (As one scientist put it, carbon supplies life's quantity, since it is the main structural element in living matter, while much scarcer nitrogen supplies its quality—but more on that later.) Originally, the atoms of carbon from which we're made were floating in the air, part of a carbon dioxide molecule. The only way to recruit these carbon atoms for the molecules necessary to support life—the carbohydrates, amino acids, proteins, and lipids—is by means of photosynthesis. Using energy from the sun the green cells of plants combine carbon atoms taken from the air with water and elements drawn from the soil to form the

simple organic compounds that stand at the base of every food chain. It is more than a figure of speech to say that plants create life out of thin air.

But corn goes about this procedure a little differently than most other plants, a difference that not only renders the plant more efficient than most, but happens also to preserve the identity of the carbon atoms it recruits, even after they've been transformed into things like Gatorade and Ring Dings and hamburgers, not to mention the human bodies nourished on those things. Where most plants during photosynthesis create compounds that have three carbon atoms, corn (along with a small handful of other species) make compounds that have four: hence "C-4," the botanical nickname for this gifted group of plants, which wasn't identified until the 1970s.

The C-4 trick represents an important economy for a plant, giving it an advantage, especially in areas where water is scarce and temperatures high. In order to gather carbon atoms from the air, a plant has to open its stomata, the microscopic orifices in the leaves through which plants both take in and exhaust gases. Every time a stoma opens to admit carbon dioxide precious molecules of water escape. It's as though every time you opened your mouth to eat you lost a quantity of blood. Ideally, you would open your mouth as seldom as possible, ingesting as much food as you could with every bite. This is essentially what a C-4 plant does. By recruiting extra atoms of carbon during each instance of photosynthesis, the corn plant is able to limit its loss of water and "fix"—that is, take from the atmosphere and link in a useful molecule—significantly more carbon than other plants.

At its most basic, the story of life on earth is the competition among species to capture and store as much energy as possible—either directly from the sun, in the case of plants, or, in the case of animals, by eating plants and plant eaters. The energy is stored in the form of carbon molecules and measured in calories. The calories we eat, whether in an ear of corn or a steak, represent packets of energy once captured by a plant. The C-4 trick helps explain the corn plant's success in this competition:

Few plants can manufacture quite as much organic matter (and calories) from the same quantities of sunlight and water and basic elements as corn. (Ninety-seven percent of what a corn plant is comes from the air, three percent from the ground.)

The trick doesn't yet, however, explain how a scientist could tell that a given carbon atom in a human bone owes its presence there to a photosynthetic event that occurred in the leaf of one kind of plant and not another—in corn, say, instead of lettuce or wheat. The scientist can do this because all carbon is not created equal. Some carbon atoms, called isotopes, have more than the usual complement of six protons and six neutrons, giving them a slightly different atomic weight. C-13, for example, has six protons and seven neutrons. (Hence "C-13.") For whatever reason, when a C-4 plant goes scavenging for its four-packs of carbon, it takes in more carbon 13 than ordinary—C-3—plants, which exhibit a marked preference for the more common carbon 12. Greedy for carbon, C-4 plants can't afford to discriminate among isotopes, and so end up with relatively more carbon 13. The higher the ratio of carbon 13 to carbon 12 in a person's flesh, the more corn has been in his diet—or in the diet of the animals he or she ate. (As far as we're concerned, it makes little difference whether we consume relatively more or less carbon 13.)

One would expect to find a comparatively high proportion of carbon 13 in the flesh of people whose staple food of choice is corn—Mexicans, most famously. Americans eat much more wheat than corn—114 pounds of wheat flour per person per year, compared to 11 pounds of corn flour. The Europeans who colonized America regarded themselves as wheat people, in contrast to the native corn people they encountered; wheat in the West has always been considered the most refined, or civilized, grain. If asked to choose, most of us would probably still consider ourselves wheat people (except perhaps the proud corn-fed Midwesterners, and they don't know the half of it), though by now the whole idea of identifying with a plant at all strikes us as a little old-fashioned. Beef people sounds more like it, though nowadays chicken people, which sounds not nearly so good, is probably closer to

the truth of the matter. But carbon 13 doesn't lie, and researchers who have compared the isotopes in the flesh or hair of Americans to those in the same tissues of Mexicans report that it is now we in the North who are the true people of corn. "When you look at the isotope ratios," Todd Dawson, a Berkeley biologist who's done this sort of research, told me, "we North Americans look like corn chips with legs." Compared to us, Mexicans today consume a far more varied carbon diet: the animals they eat still eat grass (until recently, Mexicans regarded feeding corn to livestock as a sacrilege); much of their protein comes from legumes; and they still sweeten their beverages with cane sugar.

So that's us: processed corn, walking.

3. THE RISE OF ZEA MAYS

How this peculiar grass, native to Central America and unknown to the Old World before 1492, came to colonize so much of our land and bodies is one of the plant world's greatest success stories. I say the plant world's success story because it is no longer clear that corn's triumph is such a boon to the rest of the world, and because we should give credit where credit is due. Corn is the hero of its own story, and though we humans played a crucial supporting role in its rise to world domination, it would be wrong to suggest we have been calling the shots, or acting always in our own best interests. Indeed, there is every reason to believe that corn has succeeded in domesticating us.

To some extent this holds true for all of the plants and animals that take part in the grand coevolutionary bargain with humans we call agriculture. Though we insist on speaking of the "invention" of agriculture as if it were our idea, like double-entry bookkeeping or the lightbulb, in fact it makes just as much sense to regard agriculture as a brilliant (if unconscious) evolutionary strategy on the part of the plants and animals involved to get us to advance their interests. By evolving certain traits we happen to regard as desirable, these species got themselves noticed by the one mammal in a position not only to spread their

genes around the world, but to remake vast swaths of that world in the image of the plants' preferred habitat. No other group of species gained more from its association with humans than the edible grasses, and no grass has reaped more from agriculture than *Zea mays*, today the world's most important cereal crop.

Corn's success might seem fated in retrospect, but it was not something anyone would have predicted on that day in May 1493 when Columbus first described the botanical oddity he had encountered in the New World to Isabella's court. He told of a towering grass with an ear as thick as a man's arm, to which grains were "affixed by nature in a wondrous manner and in form and size like garden peas, white when young." Wondrous, perhaps, yet this was, after all, the staple food of a people that would shortly be vanquished and all but exterminated.

By all rights, maize should have shared the fate of that other native species, the bison, which was despised and targeted for elimination precisely because it was "the Indians' commissary," in the words of General Philip Sheridan, commander of the armies of the West. Exterminate the species, Sheridan advised, and "[t]hen your prairies can be covered with speckled cattle and the festive cowboy." In outline Sheridan's plan was the plan for the whole continent: The white man brought his own "associate species" with him to the New World—cattle and apples, pigs and wheat, not to mention his accustomed weeds and microbes—and wherever possible helped them to displace the native plants and animals allied with the Indian. More even than the rifle, it was this biotic army that did the most to defeat the Indians.

But corn enjoyed certain botanical advantages that would allow it to thrive even as the Native Americans with whom it had coevolved were being eliminated. Indeed, maize, the one plant without which the American colonists probably would never have survived, let alone prospered, wound up abetting the destruction of the very people who had helped develop it. In the plant world at least, opportunism trumps gratitude. Yet in time, the plant of the vanquished would conquer even the conquerors.

Squanto taught the Pilgrims how to plant maize in the spring of

1621, and the colonists immediately recognized its value: No other plant could produce quite as much food quite as fast on a given patch of New World ground as this Indian corn. (Originally "corn" was a generic English word for any kind of grain, even a grain of salt—hence "corned beef"; it didn't take long for *Zea mays* to appropriate the word for itself, at least in America.) The fact that the plant was so well adapted to the climate and soils of North America gave it an edge over European grains, even if it did make a disappointingly earthbound bread. Centuries before the Pilgrims arrived the plant had already spread north from central Mexico, where it is thought to have originated, all the way to New England, where Indians were probably cultivating it by 1000. Along the way, the plant—whose prodigious genetic variability allows it to adapt rapidly to new conditions—made itself at home in virtually every microclimate in North America; hot or cold, dry or wet, sandy soil or heavy, short day or long, corn, with the help of its Native American allies, evolved whatever traits it needed to survive and flourish.

Lacking any such local experience, wheat struggled to adapt to the continent's harsh climate, and yields were often so poor that the settlements that stood by the old world staple often perished. Planted, a single corn seed yielded more than 150 fat kernels, often as many as 300, while the return on a seed of wheat, when all went well, was something less than 50:1. (At a time when land was abundant and labor scarce, agricultural yields were calculated on a per-seed-sown basis.)

Corn won over the wheat people because of its versatility, prized especially in new settlements far from civilization. This one plant supplied settlers with a ready-to-eat vegetable and a storable grain, a source of fiber and animal feed, a heating fuel and an intoxicant. Corn could be eaten fresh off the cob ("green") within months after planting, or dried on the stalk in fall, stored indefinitely, and ground into flour as needed. Mashed and fermented, corn could be brewed into beer or distilled into whiskey; for a time it was the only source of alcohol on the frontier. (Whiskey and pork were both regarded as "concentrated corn," the latter a concentrate of its protein, the former of its calories; both had the virtue of reducing corn's bulk and raising its price.) No part of the big

grass went to waste: The husks could be woven into rugs and twine; the leaves and stalks made good silage for livestock; the shelled cobs were burned for heat and stacked by the privy as a rough substitute for toilet paper. (Hence the American slang term "corn hole.")

"Corn was the means that permitted successive waves of pioneers to settle new territories," writes Arturo Warman, a Mexican historian. "Once the settlers had fully grasped the secrets and potential of corn, they no longer needed the Native Americans." Squanto had handed the white man precisely the tool he needed to dispossess the Indian. Without the "fruitfulness" of Indian corn, the nineteenth-century English writer William Cobbett declared, the colonists would never have been able to build "a powerful nation." Maize, he wrote, was "the greatest blessing God ever gave to man."

Valuable as corn is as a means of subsistence, the kernel's qualities make it an excellent means of accumulation as well. After the crop has supplied its farmer's needs, he can go to market with any surplus, dried corn being the perfect commodity: easy to transport and virtually indestructible. Corn's dual identity, as food and commodity, has allowed many of the peasant communities that have embraced it to make the leap from a subsistence to a market economy. The dual identity also made corn indispensable to the slave trade: Corn was both the currency traders used to pay for slaves in Africa and the food upon which slaves subsisted during their passage to America. Corn is the protocapitalist plant.

4. MARRIED TO MAN

But while both the new and the native Americans were substantially dependent on corn, the plant's dependence on the Americans had become total. Had maize failed to find favor among the conquerors, it would have risked extinction, because without humans to plant it every spring, corn would have disappeared from the earth in a matter of a few years. The novel cob-and-husk arrangement that makes corn such a convenient grain for us renders the plant utterly dependent for its survival on an animal in

possession of the opposable thumb needed to remove the husk, separate the seeds, and plant them.

Plant a whole corn cob and watch what happens: If any of the kernels manage to germinate, and then work their way free of the smothering husk, they will invariably crowd themselves to death before their second set of leaves has emerged. More than most domesticated plants (a few of whose offspring will usually find a way to grow unassisted), corn completely threw its lot in with humanity when it evolved its peculiar husked ear. Several human societies have seen fit to worship corn, but perhaps it should be the other way around: For corn, we humans are the contingent beings. So far, this reckless-seeming act of evolutionary faith in us has been richly rewarded.

It is tempting to think of maize as a human artifact, since the plant is so closely linked to us and so strikingly different from any wild species. There are in fact no wild maize plants, and teosinte, the weedy grass from which corn is believed to have descended (the word is Nahuatl for "mother of corn"), has no ear, bears its handful of tiny naked seeds on a terminal rachis like most other grasses, and generally looks nothing whatsoever like maize. The current thinking among botanists is that several thousand years ago teosinte underwent an abrupt series of mutations that turned it into corn; geneticists calculate that changes on as few as four chromosomes could account for the main traits that distinguish teosinte from maize. Taken together, these mutations amounted to (in the words of botanist Hugh Iltis) a "catastrophic sexual transmutation": the transfer of the plant's female organs from the top of the grass to a monstrous sheathed ear in the middle of the stalk. The male organs stayed put, remaining in the tassel.

It is, for a grass, a bizarre arrangement with crucial implications: The ear's central location halfway down the stalk allows it to capture far more nutrients than it would up top, so suddenly producing hundreds of gigantic seeds becomes metabolically feasible. Yet because those seeds are now trapped in a tough husk, the plant has lost its ability to reproduce itself—hence the catastrophe in teosinte's sex change. A mutation this freakish and maladaptive would have swiftly brought the plant to an evo-

lutionary dead end had one of these freaks not happened to catch the eye of a human somewhere in Central America who, looking for something to eat, peeled open the husk to free the seeds. What would have been an unheralded botanical catastrophe in a world without humans became an incalculable evolutionary boon. If you look hard enough, you can still find teosinte growing in certain Central American highlands; you can find maize, its mutant offspring, anywhere you find people.

5. CORN SEX

Maize is self-fertilized and wind-pollinated, botanical terms that don't begin to describe the beauty and wonder of corn sex. The tassel at the top of the plant houses the male organs, hundreds of pendant anthers that over the course of a few summer days release a superabundance of powdery yellow pollen: 14 million to 18 million grains per plant, 20,000 for every potential kernel. ("Better safe than sorry" or "more is more" being nature's general rule for male genes.) A meter or so below await the female organs, hundreds of minuscule flowers arranged in tidy rows along a tiny, sheathed cob that juts upward from the stalk at the crotch of a leaf midway between tassel and earth. That the male anthers resemble flowers and the female cob a phallus is not the only oddity in the sex life of corn.

Each of the four hundred to eight hundred flowers on a cob has the potential to develop into a kernel—but only if a grain of pollen can find its way to its ovary, a task complicated by the distance the pollen has to travel and the intervening husk in which the cob is tightly wrapped. To surmount this last problem, each flower sends out through the tip of the husk a single, sticky strand of silk (technically its "style") to snag its own grain of pollen. The silks emerge from the husk on the very day the tassel is set to shower its yellow dust.

What happens next is very strange. After a grain of pollen has fallen through the air and alighted on the moistened tip of silk, its nucleus divides in two, creating a pair of twins, each with the same set of genes

but a completely different role to perform in the creation of the kernel. The first twin's job is to tunnel a microscopic tube down through the center of the silk thread. That accomplished, its clone slides down through the tunnel, past the husk, and into the waiting flower, a journey of between six and eight inches that takes several hours to complete. Upon arrival in the flower the second twin fuses with the egg to form the embryo—the germ of the future kernel. Then the first twin follows, entering the now fertilized flower, where it sets about forming the endosperm—the big, starchy part of the kernel. Every kernel of corn is the product of this intricate ménage à trois; the tiny, stunted kernels you often see at the narrow end of a cob are flowers whose silk no pollen grain ever penetrated. Within a day of conception, the now superfluous silk dries up, eventually turning reddish brown; fifty or so days later, the kernels are mature.*

The mechanics of corn sex, and in particular the great distance over open space corn pollen must travel to complete its mission, go a long way toward accounting for the success of maize's alliance with humankind. It's a simple matter for a human to get between a corn plant's pollen and its flower, and only a short step from there to deliberately crossing one corn plant with another with an eye to encouraging specific traits in the offspring. Long before scientists understood hybridization, Native Americans had discovered that by taking the pollen from the tassel of one corn plant and dusting it on the silks of another, they could create new plants that combined the traits of both parents. American Indians were the world's first plant breeders, developing literally thousands of distinct cultivars for every conceivable environment and use.

Looked at another way, corn was the first plant to involve humans so intimately in its sex life. For a species whose survival depends on how well it can gratify the ever shifting desires of its only sponsor, this has proved to be an excellent evolutionary strategy. More even than other domesticated species, many of which can withstand a period of human

*My account of the sex life of corn is drawn from Betty Fussell's *The Story of Corn* (1992) and Frederick Sargent's *Corn Plants* (1901).

neglect, it pays for corn to be obliging—and to be so quick about it. The usual way a domesticated species figures out what traits its human ally will reward is through the slow and wasteful process of Darwinian trial and error. Hybridization represents a far swifter and more efficient means of communication, or feedback loop, between plant and human; by allowing humans to arrange its marriages, corn can discover in a single generation precisely what qualities it needs to prosper.

It is by being so obliging that corn has won itself as much human attention and habitat as it has. The plant's unusual sexual arrangements, so amenable to human intervention, have allowed it to adapt to the very different worlds of Native Americans (and to their very different worlds, from southern Mexico to New England), of colonists and settlers and slaves, and of all the other corn-eating societies that have come and gone since the first human chanced upon that first teosinte freak.

But of all the human environments to which corn has successfully adapted since then, the adaptation to our own—the world of industrial consumer capitalism; the world, that is, of the supermarket and fast-food franchise—surely represents the plant's most extraordinary evolutionary achievement to date. For to prosper in the industrial food chain to the extent it has, corn had to acquire several improbable new tricks. It had to adapt itself not just to humans but to their machines, which it did by learning to grow as upright, stiff-stalked, and uniform as soldiers. It had to multiply its yield by an order of magnitude, which it did by learning to grow shoulder to shoulder with other corn plants, as many as thirty thousand to the acre. It had to develop an appetite for fossil fuel (in the form of petrochemical fertilizer) and a tolerance for various synthetic chemicals. But even before it could master these tricks and make a place for itself in the bright sunshine of capitalism, corn first had to turn itself into something never before seen in the plant world: a form of intellectual property.

The free corn sex I've described allowed people to do virtually anything they wanted with the genetics of corn except own them—a big problem for a would-be capitalist plant. If I crossed two corn plants to create a variety with an especially desirable trait, I could sell you my

special seeds, but only once, since the corn you grew from my special seeds would produce lots more special seeds, for free and forever, putting me out business in short order. It's difficult to control the means of production when the product you're selling can reproduce itself endlessly. This is one of the ways in which the imperatives of biology are difficult to mesh with the imperatives of business.

Difficult, but not impossible. Early in the twentieth century American corn breeders figured out how to bring corn reproduction under firm control and to protect the seed from copiers. The breeders discovered that when they crossed two corn plants that had come from inbred lines—from ancestors that had themselves been exclusively self-pollinated for several generations—the hybrid offspring displayed some highly unusual characteristics. First, all the seeds in that first generation (F-1, in the plant breeder's vocabulary) produced genetically identical plants—a trait that, among other things, facilitates mechanization. Second, those plants exhibited heterosis, or hybrid vigor—better yields than either of their parents. But most important of all, they found that the seeds produced by these seeds did not “come true”—the plants in the second (F-2) generation bore little resemblance to the plants in the first. Specifically, their yields plummeted by as much as a third, making their seeds virtually worthless.

Hybrid corn now offered its breeders what no other plant at that time could: the biological equivalent of a patent. Farmers now had to buy new seeds every spring; instead of depending upon their plants to reproduce themselves, they now depended on a corporation. The corporation, assured for the first time of a return on its investment in breeding, showered corn with attention—R&D, promotion, advertising—and the plant responded, multiplying its fruitfulness year after year. With the advent of the F-1 hybrid, a technology with the power to remake nature in the image of capitalism, *Zea mays* entered the industrial age and, in time, it brought the whole American food chain with it.