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needed Hooker and his gifts: they earned status by being involved in the new science.

Hooker had a strong vested interest in being the sole person to define a species. Like Darwin, he deplored 'species-mongers', today known as splitters, who described variants as species in their own right. Hooker's theories of plant distribution depended on a broad species concept, so it was important that he maintained control of the definitions. He also defined localities. Collectors of the time recorded broad regions of sample origin, such as southern India, rather than specific



Hooker's drawing of a red alga, *Delesseria*.

coordinates. Today we do the reverse using georeferencing.

According to historic accounts, Hooker was a reluctant convert to the theory of evolution by natural selection. Enderby shows that the story was more complex. Hooker supported Darwin but did not think that evolutionary theory affected botany in practice, noting that the evolutionist must "employ the methods and follow the same principles that guide the believer in their being actual creations". This view sounds familiar to anyone who was involved in the pattern-cladistics furore of the 1980s, when a set of systematists

were accused of being 'anti-evolution'. Evolution by natural selection remains the most robust explanation for the generation of biological diversity. Study of what that diversity entails can be theory-free, as Hooker contended, but studying diversity in the light of evolution is more satisfying.

It is surprising how familiar the debates of nineteenth-century science sound today. By concentrating on practice, *Imperial Nature* reminds us that although theories are important, the evidence on which they are based comes from many sources and through many cultures. One hopes that Hooker's attempt at central control could never happen today, with our vibrant, diverse and more equitable communities.

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Staving off the global food crisis

The End of Food

by Paul Roberts

Houghton Mifflin/Bloomsbury: 2008. 416 pp. \$26/£12.99

Sometimes an author gets lucky, or is truly prescient. He can work for years researching a complex and obscure topic, only to see it hit the headlines just as his book is published. Suddenly, the topic is hot.

Food is hot. If high supermarket prices have not grabbed the average citizen's attention, the world food crisis surely has. With food riots from Haiti to Egypt and panic-buying of rice in Hong Kong and Vietnam, food scarcity is the topic of the day. Following on from his earlier best-selling book *The End of Oil*, Paul Roberts's *The End of Food* taps into these timely concerns.

Food crises tend to recur in history. The most severe in recent times was the world food crisis of 1973–75. Even the Old Testament of the Bible talks of years of glut and famine, and the role of good governance in smoothing out supply.

Are our worries about food different this time? Perhaps in the future we will see constantly high prices, the re-establishment of food scarcity in the developed

world after decades of surplus, and widespread hunger. Or perhaps a technological solution will lessen the tension between a growing human population and the natural resources that feed it. Will there be a continuation of the trends that Roberts documents so well, of perpetually lower prices, greater reliance on world trade to source the cheapest commodities, the spread of meat-intensive diets with increasing affluence, and more land used to grow corn for ethanol to fuel our cars?

Roberts's answers are clear. The global food system, as it is currently structured and driven, is heading for a cataclysm. Roberts offers a sobering scenario of a 'meltdown': "We are already growing fatter (and hungrier), depleting more soil organic matter, drawing down more water tables, using more fertilizers and pesticides, losing more acres of forests and farmland." Consequently, he warns, "There is no longer the possibility of discrete failure; a collapse of one part of the system will have extraordinary ramifications for everyone else."

The End of Food makes the case that system-wide collapse is inevitable. Roberts starts by recognizing that economic forces drive the world food system, although our basic biological needs for nutrition have not changed since we evolved. This tension between food as an economic commodity — produced, processed, even speculated on as if it were copper or steel — and as a biological necessity is not new. But Roberts argues that globalization of our food supply and the westernization of dietary demand have driven the entire system irrevocably out of balance.

The result is a list of woes. The industrialization of the food industry creates a need for sources of cheap inputs and continual supply of new products. The retail revolution has led to a tendency to offer 'supersize' portions to push up demand. Obesity is the



Supporters of the Gabriela political party protest against rising food prices near president Gloria Macapagal-Arroyo's palace in the Philippines in April.

L. LIUWANG/AFP/GETTY IMAGES

consequence of these two transformations of the food system. Global trade is able to supply progressively cheaper food, at high cost to humans and the environment, yet there is a paradox of plenty amidst widespread hunger. Food-borne diseases resulting from modern farming techniques for livestock have also sharply raised the probability of an uncontrollable pandemic.

Roberts is not hopeful of a solution to these problems because of the economic forces that dominate. He avoids conspiracy theories, but distrusts the coordination between the producers and consumers that is central to the capitalist system. He is not alone. To paraphrase British prime minister Winston Churchill on democracy, capitalism is the worst way to organize society's economic activities, except for all of the alternatives. Communist Cuba, for example, returned to a system of local food production using human and animal power to produce a nutritionally adequate diet. Roberts accepts this is hardly a good global solution.

There are two approaches to making our food system safer and more sustainable, yet still accessible to the world's population, which is expected to increase by two billion during the next 30–50 years. Both strategies should be pursued simultaneously.

First, and ironically in view of Roberts's critique, the global capitalist system needs to be harnessed to help solve problems of food scarcity, pricing and inequity. Fortunately, it is already moving in the right direction. The rising cost of energy makes many elements of the food industry unprofitable. High fertilizer prices, high transportation costs and high meat prices all push the system towards less intensive, locally produced and healthier alternatives.

Second, good public policy and government investments in food and agricultural research can make a big difference. More-effective regulation, better-educated consumers and healthier school environments can all follow from elected officials who care about the quality and quantity of the food they and their families eat.

The End of Food is a call to arms. But there will be no revolution. We will all be buried in our oversized coffins before a radical solution comes, because change will be gradual. So we must get on and fix the system we have. ■

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Horse power unbridled

The Horse

American Museum of Natural History, New York

Until 4 January 2009.

Noble, speedy, dependable and strong, the horse changed the course of human history. The domestication of *Equus caballus* some 6,000 years ago supplied people with a reliable year-round source of food, enabling them to settle in villages and ride to communities farther afield. Horses have since helped humans plough fields, carry supplies, haul water, mine coal, fight battles and conquer continents. The animals raced through the earliest art and have a renowned place in religion and sport.

They also inspired the invention of trousers.

As explained in *The Horse*, an exhibition at the American Museum of Natural History in New York, trousers were designed for the comfort of riders, and only later adapted for more general use.

They appear on a fifth-century BC urn from southern Italy that depicts a duel between an Amazon woman and a Greek warrior. Mounted on a horse and clothed in striped Persian pantaloons, the Amazon aims her spear at the Greek, who fights back helplessly on foot. The exhibition emphasizes that humans owe more to horses than practical fashion; curator Ross MacPhee calls the animals "the first multipurpose engines, animated machines".

Horses helped power the Industrial Revolution: they hauled goods from steamships or trains to warehouses and markets. Horses often worked in tandem with machines; by the 1870s, more than 300 US patents had been issued for horse-powered machinery. One horse-drawn contraption on display is a three-metre-long, three-tonne steam fire engine made of iron and steel, dating to 1896. Before the mid-nineteenth century, men pulled and hand-pumped fire engines. A draft horse is strong enough to lift 150 kilograms a distance

of 30 metres in one minute, or, as Scottish inventor James Watt calculated in the 1770s, 33,000 'foot-pounds' per minute, a quantity he defined as one horsepower. Museum visitors can pull down a lever and measure their own strength: after some practice and puffing, and by using both hands, I scored about a fifth of one horsepower.

The great mobility of horses derives in part from their ability to graze and digest grass on the go, enabling them to walk all day. Their speed hails partly from their single hooves, which evolved around 12 million years ago in a genus called *Pliohippus*, relatives of modern-day *Equus* — single hooves enabled them to run farther and faster than their three-toed, forest-dwelling ancestors.

These adaptations helped the cavalries of Genghis Khan and his descendants to conquer most of Asia, the Middle East and Russia. Mongol horsemen

did more than pillage: they spread innovations along the Silk Road such as the bow fiddle, which originated in central Asia around 1,000 years ago and had a bow strung with horsetail hair.

A modern Mongolian example of the *morin khuur*, the horsehead fiddle, is on display, as are other forms of horse-inspired art: reproductions of 32,000-year-old paintings of horses

galloping gracefully along the walls of the Chauvet cave in France; children's toy horses; and a garland-trimmed, 2-metre-long terracotta horse from Tamil Nadu, India, created as an offering to local gods.

A powerful bond exists between humans and horses. A film exhibit shows an organization called GALLOP, based in Brooklyn, New York, which provides therapeutic horseback rides for people with disabilities. In one segment, Sarah Lisker, a girl who has cerebral palsy, is lifted from her wheelchair onto a horse and parades around confidently, assisted by an instructor. "What did the horse teach you?" the instructor asks. "That I'm his friend," Sarah replies, and then murmurs, "Trot on." ■

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A brass toy horse and soldier from India.

AMNH/D. FINNIN