Cane. If the warming now fades, the 1986–87 ENSO event will have been a relatively weak one that in the central Pacific peaked early, much like the predicted event. On the negative side, there was a considerable gap between predicted and observed temperatures last summer when the model called for a continuation of the early warming rather than the near normal conditions that prevailed.

Like most researchers in the ENSO community, Rasmusson will not say whether this is the event predicted by Cane and Zebiak, but "we did get a warming. It may not have developed as modeled, but we cannot shrug it off. They should feel pretty good about it. It's never been done before. At least this time we were highly suspicious; before we weren't even suspicious."

If the Cane and Zebiak prediction proves to have been well founded, meteorologists and oceanographers alike will know what part of the ocean-atmosphere system to monitor for signs that El Niño is ready to return. "We have a theory of how this works," says Cane, "that focuses very strongly on the amount of heat in the ocean." In their model, the accumulation of sufficient warm water in the tropical ocean is like the loading of a gun. Disturbances in the ocean-atmosphere system that could set the gun off occur frequently, Cane says, but it cannot go off unless it is loaded.

"Even after all those unfavorable conditions in the spring, it still happened," says Cane. "That suggests that this is a relatively robust phenomenon. If it's going to go, it's going to go."

Another new essential element of the model is a means for returning to anti-ENSO conditions. During an intensifying ENSO event warm water sloshes from the western into the eastern Pacific as the westward winds that had kept the warm water piled in the west weaken. Because those winds are driven by the temperature contrast that is rapidly being erased, a positive feedback between the wind and water temperature drives the ocean-atmosphere system faster and faster toward ENSO conditions.

In order to break out and return to anti-ENSO conditions, the model includes not only west-east winds and water flow along the equator but also poleward flow, a somewhat counterintuitive result of the disappearance of the Coriolis effect at the equator. This poleward flow drains the tropical reservoir of its excess warm water and then some, returning the system to the anti-ENSO state until enough warm water returns from higher latitudes to reload the gun. Westward winds may slacken in the meantime for any number of reasons, but without sufficient warm water the chain reaction of the positive feedback cannot take hold, according to the theory.

There remain plenty of loose ends. This event must still play itself out—a few researchers have suggested that this may be the beginning, not the end, of an event. If it soon fades, as most expect, the next chore will be to determine why not only the Cane and Zebiak model but also the short-term prediction models seemed to work. And then there is the even thornier problem of predicting the effects on weather around the globe. Even if a forecaster were certain of the timing and magnitude of a Pacific warming, the background variability of the atmosphere and the variability of its response to a warming would make useful forecasting difficult. As Cane notes, "The last thing I want to convey is that it's all solved." ■

RICHARD A. KERR

ADDITIONAL READING

M. A. Cane, S. E. Zebiak, S. C. Dolan, "Experimental forecasts of El Niño," *Nature (London)*, **321**, 827 (1986).
R. A. Kerr, "Another try at forecasting El Niño," *Science* **232**, 155 (1986); "Predicted El Niño failing to show," *ibid.*, p. 1604.

Wet-Nursing Boom in England Explored

From 1500 to 1700, wealthy English women did not nurse their babies—and had anywhere from a dozen to 20 or more children

For the past 5 years, Valerie Fildes of Edinburgh, Scotland, has been scouring historical records of infant feeding in England, asking what determined family size during the period 1500 to 1700 and why. Her results, says demographer Roger Schofield of Cambridge University, are "extraordinary."

Fildes' major observation is that well-to-do English women of that time "had anywhere from a dozen to 20 babies and even 30 babies was not unusual." They could become pregnant so often, Fildes writes, because they did not nurse their babies. As soon as a baby was born to a wealthy woman, she gave it to a wet nurse. She then became pregnant again almost immediately.

Breasts, Bottles and Babies, Fildes' recent book,* should be of particular interest to biologists and medical historians. Reproductive biologist Ann McLaren of the Medical Research Council in England says she was "fascinated by all the historical details," and impressed by the scholarship that went into the book. Schofield says what interests him is the information Fildes dug up on people's attitudes toward breast-feeding, the "Dr. Spock–type literature of the era," as he puts it.

The wet nurse boom began in England around 1500, according to Fildes, when it became the fashion for wives of the aristocracy, gentry, and other wealthy families to forgo nursing their own babies. By the early 18th century, even less wealthy women, such as the wives of shopkeepers, were hiring wet nurses.

The results were dramatic. Because lactation induces amenorrhea, nursing women are much less likely to become pregnant than women who do not nurse. Women who used wet nurses, and gave up the contraceptive effect of lactation, could then become pregnant almost immediately after giving birth and end up with a new baby virtually every year.

Women said they did not nurse because they felt it would make them look old before their time.

It was known at the time that lactation is a means of birth control, Fildes points out. For example, Hugh Downman, a Devon physician wrote in 1788 that "the nursing time was meant by wisest Nature, as a stay." And the Duchess of Devonshire wrote around the same time that her relatives did not want her to nurse her baby daughter because of their "impatience for my having a son and their fancying I shan't so soon if I suckle."

Parents saw very little of their young children. Nurses did not live with the families they worked for and, in fact, frequently lived miles away. Some London women, for example, sent their babies to nurses in Che-

*Edinburgh University Press, Edinburgh, 1986.

sham, 27 miles away and many parents did not visit their children or visited them only infrequently. Even parents who sent their children to nurses who lived nearby did not routinely visit them. And if a child died, the parents did not always attend the funeral.

It sounds like a very difficult way of life—the women were almost continuously pregnant, their children had a high mortality rate, and parents barely got to know the children anyway until they were about 2 years old. So why did wet-nursing become so popular? One reason, apparently, was vanity. Women said they did not nurse because they felt it would make them look old before their time, because their clothes would be soiled, and because their breasts would sag and be scarred. "Fears about sagging and scarred breasts were a reality for all women during this period, as evidenced by the many pages which midwifery writers devoted to diseases of breasts and nipples and to their remedies," Fildes writes. "It apparently was not unusual for women who breast-fed to lose their nipples completely, either because of repeated cuts, which became infected and left disfiguring scar tissue, or because hungry older children (equipped with teeth) chewed them off."

Protestant theologians urged women to breast-feed, saying that nursing creates a much closer bond between mother and child. Many men, however, encouraged their wives to use wet nurses. The Puritan William Gouge, for example, wrote in 1622, "Husbands, for the most part, are the cause that their wives nurse not their own children." In 1695, the minister Henry Newcome said, "Very oft the father is unwilling that his wife should undertake this office."

Visiting the wet nurse. *In this 1788 painting by George Morland, a British mother and her older child visit her infant at the nurse's home.*

In 1792, Mary Wollstonecraft wrote in her book *Vindication of the Rights of Women*, "There are many husbands so devoid of sense and parental affection that during the first effervescence of voluptuous fondness, they refuse to let their wives suckle their children."

Not all husbands were opposed to nursing, yet even when well-to-do women were also encouraged to breast-feed by their husbands and close friends, they would frequently say they could not because they had no milk. So common was this excuse that the Puritan writer Henry Smith wrote in 1597 that this lack of milk seems to be a peculiar attribute of the well-to-do. "But whose breasts have this perpetual drought? Forsoothe it is like the goute, no beggars may have it, but citizens or Gentlewomen."

The situation in England differed from that in the rest of Europe, according to Schofield. Among Protestants of Northern Europe, women of all classes breast-fed. Among Catholic women, there was more variation. The Roman Catholic church encouraged wet-nursing because church doctrine forbade sexual intercourse when a woman is lactating. By using a wet nurse, church documents said, a woman could "provide for the frailty of the husband" by avoiding lactation entirely and having intercourse while her baby was still an infant. But in northern Germany, Catholic women breast-fed their babies anyway, according to Schofield. In Italy, says historian David Herlihy of Brown University, wet-nursing was the norm for those who could afford it.

But even in Italy, the social customs made it unlikely that women had enormous families, as the wealthy did in England. "Richer women would frequently marry young, but they would marry older men. They would be widowed early and so the duration of the marriage was short," Herlihy says. As a consequence, even women who used wet nurses had only about five children.

In England, middle class and poorer women tended to marry when they were in their mid-20's and to have their last child when they reached age 40, according to Schofield. They ended up with about six or seven children. The reason for this relatively late age was that couples needed to be economically independent before they married.

But the English aristocracy was different. "The major difference is that they married younger. The wives were in their midteens and the husbands were not much older," Schofield says. By the time an aristocratic woman reached the end of her childbearing years, she could easily have borne a dozen to 20 children. In the end, however, this extreme fecundity backfired on the aristocracy,

Saying goodbye to the baby. *In this 1780 French painting, a mother kisses her baby goodbye as the wet nurse takes it off to the country.*

according to Schofield. "There were too many surviving and it became impossible to divide even an aristocratic inheritance among so many children." So, after a couple of hundred years, "the age of marriage among the aristocracy went up and up, reaching the 30's for women and the 40's for men," Schofield says.

During the time when wealthy English women married young and gave up nursing, there was a concurrent trend throughout the society to supplement breast milk with pap, made from animal milk, cereal, flour, sugar, and spice, or with panada, made with broth, bread crumbs, and flavorings. Some wealthy women relied on "hand-feeding" because they feared a wet nurse's temperament could be passed on to their child through the milk. Foundlings were hand-fed because it was cheaper than hiring a wet nurse.

For a while, a hand-feeding fad took hold because the aristocracy copied the royal family. It began in 1688, when King James II decided to have his infant son reared entirely on such supplementary foods because several previous children had died while being wet nursed. By the time the baby was 7 weeks old, however, he was so close to death that the king relented and sent for a wet nurse. The child survived, but members of the aristocracy continued to use these supplementary foods, reasoning that if the king did it, it must be the fashion. In 1710, the infant son of the Duke of Buckingham died of starvation after his father insisted that he be reared by hand.

Hand-feeding also became the preferred method of rearing foundlings—with sometimes disastrous results. During the last quarter of the 18th century, for example, 10,227 babies died at the Dublin Foundling Hospital—a mortality rate of 99.9%.

The wet-nursing and artificial-feeding trend gradually died out by the end of the 18th century, for a variety of reasons. A major one, according to Fildes, is that medical writers began to focus their attention on the health and well-being of mothers. In addition, Fildes writes, "there was an apparent decline of the husband's influence in decisions about how his children were to be fed."

What Fildes shows in her book, says Schofield, is that, "for most people, their preconceptions [about infant feeding] will be incorrect." It is, he says, "a very interesting piece of work." ■ GINA KOLATA

National Academy Looks at Human Genome Project, Sees Progress

A year after the Human Genome Initiative began, biologists are beginning to come to terms with the goals and organization of the project; specialized centers are proposed

In what will be one of its most rapidly produced committee reports, the National Academy of Sciences is preparing a commentary on the current initiative to map and sequence the human genome. The Academy's committee on the topic, convened under the Board on Basic Biology, had its first meeting at the end of January and plans to publish its conclusions by June.

The committee, chaired by Bruce Alberts of the University of California in San Francisco, joins a growing list of national bodies currently contemplating this major project, and this includes the Department of Energy (DOE), the National Institutes of Health (NIH), and the Office of Technology Assessment. Like members of a traveling circus, appointees to these various committees often overlap and find themselves moving from meeting to meeting to discuss the same issues with the same colleagues. "The ratio of talk to progress is still high," says Charles Cantor of Columbia University Medical School and a member of the Academy's committee, "but people are moving toward a consensus about how this project should be structured."

The fact that ideas of structure and organization are now being seriously considered is significant and reflects a real evolution of the biological community's response to the prospect of a megaproject of a scale and cost more familiar to physical scientists. "It is clearly no longer a question of whether the project ought to be done," commented University of California biologist Russell Doolittle after the Academy committee's recent gathering, "but of how fast it will be done."

Cantor agrees. "The idea of the project went through a period of doubt, when the biological community heard of the huge initial estimates of cost [$3 billion] and became concerned about the potential diversion of funds from other research," he says. "But now there is a much more upbeat tone."

The principal organizational idea that began to emerge from the Academy committee's discussions was the establishment of about half a dozen research centers that would concentrate on specific aspects of the problem, including mapping, sequencing, technology development, and data analysis. This arrangement would allow the exploration and development of new approaches to the problem to go along with what committee members kept referring to as "real science." The business of ultimately trudging through all 3 billion bases of the human genome would, most agreed, have to be tackled in some kind of factory approach. "That's not science," commented Walter Gilbert of Harvard University, "that's production."

"The ratio of talk to progress is still high, but people are moving toward a consensus of how this project should be structured."

Although the Academy committee's discussion gave a sense that the human genome project was at last on its way, there was also a clearer recognition than has been apparent at previous gatherings that the practicalities are going to be even tougher than at first acknowledged. It was not that the committee heard any startling new evidence or covered new territory, but, as one member observed, "people got past the rhetoric" and faced up to the practical limitations of current techniques. The tenor of the discussion, not the substance, was different—it was more pragmatic, more self-critical. "There is a growing conviction that the technology is not yet good enough," says Lee Hood of the California Institute of Technology. "At worst, it might fail to complete the job, or at best it might be extremely expensive."

It is now little more than a year since the real push to characterize the human genome began, inspired principally by Charles DeLisi of the DOE's Office of Health and Environmental Research. Significantly, the name of the enterprise has proved to be mutable during that time, changing from the "Genome Sequencing Initiative" to simply the "Genome Initiative." What once was the rallying call—the entire nucleotide sequence of the human genome—has become muted, and in the Academy committee's formal statement of task it is characterized as "a subsidiary goal." The primary goal is "to map the human genome."

The ideal physical map of the human genome would actually be a line of bottles, each of which would contain DNA fragments about 40,000 bases long, the position of which on the genome would be accurately known. Producing individual fragments of this sort—which are known as cosmids—has been part of biologists' tool kit for some time. The challenge is to blanket the 30 billion bases of the human genome with overlapping cosmids so that there are no gaps in the map. That is a tough task, especially as some parts of the genome, particularly those with long stretches of repeated sequences, will prove very difficult to clone.

The Academy committee heard from Maynard Olson of his Washington University group's endeavors to produce much bigger clones, which potentially reduces the magnitude of the problem. Nevertheless, asked by Alberts "what scale of effort would be required to map the human genome using these approaches?" Olson replied, "huge." Sydney Brenner, of the Medical Research Council's Laboratory of Molecular Biology in Cambridge, England, reported on his group's progress with mapping the nematode genome using a technique that