known—it can cause sensory and motor problems in adults and mental retardation and other effects in children exposed to high levels in the womb—scientists have argued for years about whether low levels are harmful. Five years ago, EPA sparked a controversy when, citing data from a 1971 poisoning incident in Iraq, it proposed reducing the safe level for mercury exposure to 0.1 micrograms per kilogram of body weight per day. That decision put EPA at odds with other federal agencies, such as the Food and Drug Administration (FDA), whose standard was five times higher.

Critics from industry and other agencies jumped on the EPA decision. They argued that the agency should rely on new studies of mercury's low-level effects, and when EPA did, they challenged its interpretation of those studies. The debate revolves around dueling findings.

The critics cite a study that has found no damage to neurological development in 700 5 1/2–year-olds born to mothers who ate mercury-contaminated fish in the Seychelles Islands in the Indian Ocean. The latest results of this ongoing study were published in 1998. EPA, in turn, has relied on a Danish study of children in the Faroe Islands in the North Atlantic, which did find neurological harm at low-level exposures. The critics contend that this study is flawed because the mercury-tainted whale meat that the Faroe islanders ate also contained polychlorinated biphenyls (PCBs) and other pollutants known to affect neurodevelopment. But EPA stuck by its analysis. "We concluded PCBs were not the basis" of the effect, says Kate Mahaffey, then EPA's lead scientist on mercury risk assessment. When scientists couldn't agree on which study was more reliable, Congress requested the academy report.

To the critics' surprise, the NAS panel placed more faith in the Faroe Islands study. At the panel's request, the Danish investigators excluded the data for children who were also exposed to high PCB levels; the remaining subjects still showed neurological effects from exposure to low levels of mercury, says retired pathologist Robert Goyer from Chapel Hill, North Carolina, who chaired the committee. "We're not really clear why the Seychelles Islands [study] is different, but we feel very confident in the [Faroe Islands] results," says Goyer—especially because a recently published New Zealand study also found low-level effects.

"We're very pleased by the support the academy has given to the scientific justifiability of EPA's [proposed standard]," says Mahaffey. But critics are underwhelmed. "We're very disappointed," says neurologist Gary Myers of the University of Rochester in New York, a member of the Seychelles study team. Myers and others—including a scientist at the Department of Health and Human Services who spoke with *Science*—argue that, although they haven't yet read the NAS report, any attempt by the Danish researchers to separate the effects of PCBs was questionable because they didn't adequately measure exposure to PCBs and related pollutants in the first place. And they fault the New Zealand study, which involved about 200 children, in part for being too small.

Alaska state epidemiologist John Middaugh and other critics say they don't oppose EPA's plans to clamp down on industrial mercury emissions. But they worry that communities that depend on fish for their primary source of protein may stop eating fish. That would be counterproductive, they say, as the benefits of eating fish on developmental and cardiovascular health may outweigh the risks (*Science*, 12 December 1997, p. 1904). FDA and other agencies must now decide whether to adjust their safety levels for mercury. They say they plan to weigh all the evidence—including the latest results, expected in 2001, from the Seychelles children.

–JOCELYN KAISER

DEVELOPMENTAL BIOLOGY

Why Chicks Aren't All Thumbs

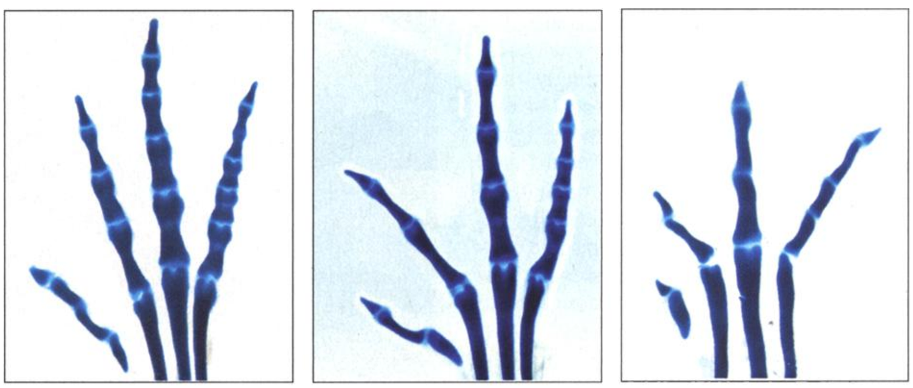
Imagine what it would be like trying to play the violin or eat with chopsticks if your fingers were all thumbs. Having fingers and toes of various sizes is not only handy, but also has allowed humans to conquer nearly every ecological niche on our planet. Just why a pinkie becomes a pinkie and not another thumb, however, has puzzled developmental biologists for decades. Now a new study on page 438 offers some surprising insights on when and how digits assume their distinctive shapes.

Scientists had thought that even before cartilage cells begin to develop into a finger or toe, they already know what shape digit to make. For example, cells that will form the second digit on the hand know that they should become an index finger rather than a thumb or pinkie. The new findings, however, suggest that digit identity is programmed much later in development, by chemical messengers from the surrounding tissue. "Nobody anticipated that the positional information does not reside within the digit precursors," says developmental biologist Clifford Tabin of Harvard Medical School in Boston. Because in most animals the cells of this webbing die off before birth, the new study, says Denis Duboule, a developmental geneticist at the University of Geneva in Switzerland, "demonstrates that these cells have a real function and are not simply remnants of evolution."

Chicken feet are what tripped up the decades-old single-step model of digit formation. Employing novel microsurgical techniques, developmental biologists Randall Dahn and John Fallon of the University of Wisconsin, Madison, manipulated embryonic chick limbs. The unusual anatomy of chicken feet was key to their experiments. "The nice thing about the chick foot," says Dahn, "is that all four digits have a different length and a different number of phalanges," or segments, which can be used to identify them.

If location meant identity, the researchers reasoned, then bisecting a developing third digit on a chick's foot should result in a chick with two third digits. The researchers tested this idea by puncturing eggshells and using watchmaker tools to imbed foil barriers in the center of the tiny digit precursors of the embryos. They covered the holes with clear tape and watched what happened. "What we got was very surprising," says Dahn, who for simplicity's sake uses human nomenclature to describe chick digits. "When we bisected a middle finger [precursor]," the half next to the index finger would become another index finger.

The researchers speculated that the webbing might be instructing the digit cartilage cells how to develop. And indeed, when Dahn and Fallon attached an index precursor between the ring and pinkie precursors, the transplanted digit that developed had the same



BMP's fingerprint. Boosting BMP levels spurs extra digit segments *(left)*, while reducing levels results in fewer *(right)* compared to normal chick foot *(center)*.

CREDIT: R. DAHN *ET AL*

number of phalanges—four—and the overall shape of a ring finger. "That really told us it's the interdigital regions that lay down digit identity," says Dahn. It also suggested that interdigital signals are transmitted "downstream" toward the thumb: That's why the digit became a ring finger and not a pinkie.

The next step was to probe how the webbing gives these marching orders. For years scientists have known that interdigital cells churn out bone morphogenetic proteins (BMPs), a family of signaling molecules crucial to the proper development of many tissues in organisms from fruit flies to humans. BMPs are also known to influence structural identity: A team led by Paul Sharpe at Guy's Hospital in London recently demonstrated that altering BMP levels in the lower jawbone of mice results in molars sprouting where incisors should be. Following this lead, when Dahn and Fallon implanted tiny beads in chick feet that slowly released a BMP inhibitor into the webbing, downstream digits always developed fewer segments than expected. Conversely, a BMP-boosting protein increased the segment number downstream. "The stronger the BMP signal, the more phalanges," Dahn says.

He and Fallon suggest that the BMP signal from the chick interdigital regions rises stepwise in strength from thumb to pinkie, programming an increasing number of digit segments along the way. Although "there's no evidence yet for a gradient of BMP signaling," says developmental biologist Gail Martin of the University of California, San Francisco, she says the duo has proposed an extremely promising model that may well explain how digit identity is assigned.

–MICHAEL HAGMANN

ASTRONOMY

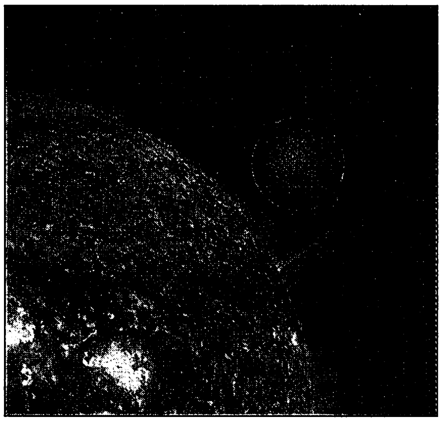
Brown Dwarf's Flare Opens X-ray Eyes

When the Chandra X-ray Observatory pointed its snout at a failed star 16 light-years away, astronomers expected it to see little sign of activity. Instead, the orbiting telescope got smacked in the eye by an x-ray flare—and astrophysicists are still trying to explain why.

The source of the flare, a brown dwarf called LP 944-20, is a stellar underachiever. When it formed, about 500 million years ago, there wasn't enough hydrogen in the area to start nuclear fusion at its core. As it collapsed under its own gravity, it warmed up slightly, but since then it has been cooling and fading.

So when Gibor Basri, an astrophysicist at the University of California, Berkeley, and colleagues pointed Chandra at the dwarf, they expected little in the way of high-energy light. "We wanted to put a new upper limit on the x-ray flux from brown dwarfs," says Basri. "According to what happens at low temperatures to stellar activity, we expected to see nothing."

For the first 9 hours of Chandra's 13-hour run, they saw exactly that. Then the observatory's x-ray counter started ticking: The brown dwarf was flaring. "It was quite exciting," says Thomas Fleming, an astronomer at the University of Arizona's Lowell Observatory in Flagstaff. "It's a fly in the ointment."



Sunstroke. Though not active stars, brown dwarfs can emit bursts resembling solar flares.

The problem posed by LP 944-20's sudden outburst is that in general, x-ray flares go hand in hand with other powerful x-ray activity. Both arise because stars are huge dynamos that create magnetic fields. A rapidly spinning star stretches and twists the field lines. The greater the kneading, the fiercer the blast of x-rays from the star's corona, its halo of wispy, million-degree plasma. Sometimes the magnetic field lines get so tangled that they snap and reconnect, causing an explosion, or flare.

Our sun, which spins on its axis roughly once a month, is constantly belching flares and glowing with x-rays. Brown dwarfs, however, can spin much faster; LP 944-20, for example, rotates once every 5 hours. If brown dwarfs had sizable magnetic fields, astronomers concluded, then they would have hot coronas and powerful x-ray emissions, too. But nobody had seen much x-ray activity; therefore, brown dwarfs had to have weak magnetic fields.

The first 9 hours of the Chandra observations backed this theory up, as Chandra detected almost no x-ray activity from the dwarf. But the flare threw a wrench in the works. "The flare tells us that magnetic fields are still there," says Basri. So why no sign of a corona? "It's quite curious that there are only flares and no hot plasma at all," Fleming says. "We have to find a reason or an explanation."

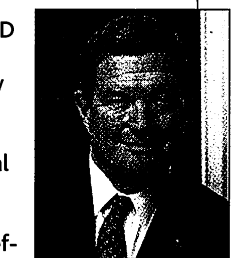
One possibility is that the outer atmosphere of the brown dwarf consists of electrically neutral atoms; deeper inside, the atmosphere contains many charged ions. The neutral atoms wouldn't knead the magnetic

CREDIT: (TOP) SOHO/NASA (SUN), CXC/K. KOWAI (BROWN DWARF)

ScienceScope

Czech Rebound After enduring a decade of bleak postcommunist science budgets, Czech scientists are celebrating a bigger budget and a new program. The government this year gave science a 20% boost to $300 million, fulfilling an earlier promise to raise R&D's piece of the budget pie from 0.5% of GDP in 1999 to 0.6% in 2000 toward a goal of 0.7% by 2002. Besides fulfilling the country's contributions to the European Framework 5 research program, the extra money will endow a new 5-year program to strengthen research groups within top institutes. Starting this month, 33 competitively chosen centers studying everything from humanities to genetics will get grants for equipment, overhead, and salaries for postdocs and young scientists. Each center will receive, on average, $3 million for 5 years. And to bolster university-based science, each must recruit an academic partner. "We're trying to improve the quality of research," says Josef Syka, vice chair of the government's Research and Development Council.

Double Trouble Thirteen senators have so far thrown their weight behind an effort to double the National Science Foundation's (NSF's) budget to $8 billion by 2006. In a 12 July letter to Senate leaders Trent Lott (R–LA) and Tom Daschle (D–SD), the lawmakers touted investments in R&D and education as "the building blocks of the new economy" and noted that Congress has already put the budget of the National Institutes of Health on a doubling path. "It is now time to launch a parallel effort" for NSF, concluded Senators Kit Bond (R–MO, above) and Barbara Mikulski (D–MD), the letter's lead authors and senior members of the appropriations subcommittee that funds NSF.



Science lobbyists say the letter should revive a bid to double the NSF budget, currently bogged down in politics (*Science*, 7 July, p. 31). "It signals that the idea is being taken seriously," adds a Senate appropriations aide. But he notes that House lawmakers have already severely trimmed the Administration's $675 million requested increase for 2001, a major step toward doubling. The question now, he says, is whether the Senate "can muster the votes to turn things around."

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