receptor is playing the proposed role in CAM responses in the brains of living animals. Also unclear is exactly how the CAMs activate the FGF receptor. Although other scenarios haven't been ruled out, Walsh and Doherty think that the current evidence favors the idea that stimulation of neurite outgrowth begins with a CAM on a growing neuron contacting a CAM on a neighboring cell. This recognition event then leads the CAM on the neuron to nudge up against an FGF receptor in the same membrane, activating the receptor tyrosine kinase and setting off a pathway that ultimately produces neurite growth.

While Doherty and Walsh were the first to suggest a direct molecular interaction between adhesion molecules and a growth factor receptor, other researchers are also pursuing the interactions between CAMs and cellular growth pathways. But in these cases the adhesion molecules generally don't interact directly with the growth factor receptors themselves. Take the integrins, which attach neurons and numerous other cell types to the proteins of the extracellular matrix. Integrins appear to interact with pathways activated by platelet-derived growth factor and insulin, but in this case the two signals appear to cross paths inside the cell, downstream of the growth factor receptors.

These findings are intriguing, says cell biologist Erkki Ruoslahti of the La Jolla Cancer Research Foundation in California, one of the researchers doing the integrin work, because it suggests there are many possible levels of interaction between CAMs and growth signaling pathways. "We know that FGF receptors do not cooperate with [the] integrin [that interacts with insulin signaling]. Perhaps every adhesion receptor has its own growth factor receptor partner!" Indeed, Thiery predicts that the emerging story of CAM action will force a re-evaluation of the molecules' role in development and other cell activities. "These adhesion molecules," he says, "are perhaps smarter than we thought at first."

–Claire O'Brien

Claire O'Brien is a science writer in Cambridge, U.K.

ENDANGERED SPECIES

Ivory Identity Crisis Still Unsolved

How can you tell one piece of ivory from another? That question vexes would-be ivory traders in Africa, where a bloody decade of poaching in the 1980s decimated many elephant herds, especially in east Africa. In response to the slaughter, in 1989 the Convention on International Trade in Endangered Species (CITES) banned international trading of ivory. East African nations support the ban, which has had the desired effect: The price of ivory has plummeted, and poaching pressure has plunged along with it. But in southern Africa, wildlife managers are killing elephants to keep their numbers in check and are watching stockpiles of ivory grow. As early as 1992, these nations pushed to reopen the ivory trade. But opening the trade would require a reliable method to distinguish legitimate sources from black-market ivory taken from poached animals.

Back in 1990, it seemed that geochemistry could come to the rescue. Two pilot studies published in *Nature* that year suggested that the isotopic composition of ivory could provide a cheap and easy way to pinpoint its source. Elephants pick up the isotopic imprint of their habitat, and the pilot studies suggested that each locality sampled had a characteristic isotopic "fingerprint." But on page 1340 geochemist Paul Koch of Princeton University and his colleagues report new results that cast doubt on the usefulness of isotopes for this work.

They found that when habitats change—as is happening in many parts of Africa—isotope values in elephants change, too. As a result, animals from a single locality showed a wide range of isotope values rather than a unique signature. "The study shows that this technique doesn't work to source ivory," says Andrew Dobson, an elephant ecologist at Princeton who is familiar with the work. "There's just too much variability within one locality." Although the authors of the original studies aren't ready to give up on their method, the new results weaken the case for opening any trade in ivory, says Dobson.

Like the pilot studies, the new work probes the carbon, nitrogen, and strontium isotopes in elephant bone and teeth. (Koch wasn't allowed to analyze tusk because importing tusk samples would violate U.S. law, according to the U.S. Fish and Wildlife Service.) But while the earlier papers sampled localities around Africa, Koch focused on one well-studied area—Amboseli National Park in Kenya. The isotopic values of Amboseli elephants overlapped somewhat with those measured in animals elsewhere in Africa. The carbon isotopes from Amboseli animals were particularly variable—"almost useless for forensics," Koch says.


KOCH ET AL.

Heavy meal. A grass diet gives elephants a higher ^{13}C to ^{12}C ratio than browse does.

In Amboseli, this variability reflects a change in habitat caused partly by the animals themselves. Elephants eat trees and shrubs (browse), as well as grass. During the past 15 years or so, the animals have concentrated in Amboseli, eaten the available browse, and the park's grasslands have expanded. As a result, the elephants' diet has become richer in grass. Because grasses contain a higher proportion of ^{13}C than browse, this shift showed up in the isotopic ratios. Elephants who died in the 1970s, for example, had lower ratios of ^{13}C to ^{12}C, indicating a diet rich in browse, than did elephants who died in the 1980s. Also, microsamples from molars of different animals varied widely as a result of individual behavior. For example, two elephants called Ruth and Zach managed to find trees and shrubs in the mid-1980s, apparently by sneaking out of the park at night. The bottom line, says Koch, is that the isotopic technique is problematic for tracking ivory, although it provides information on elephants' eating habits and migrations.

But those who pioneered the method are more optimistic about its potential. John Vogel of the Council for Scientific and Industrial Research in Pretoria, author of one of the previous studies, agrees that the variability in carbon isotopes makes them less useful, but maintains that ivory sources can still be identified by a mix of isotopes. The author of the other pilot study, Nikolaas van der Merwe of Harvard University, now at the University of Capetown in South Africa, adds that the method could distinguish among a short list of suspected sources.

It may be possible to run a suite of isotopes to distinguish elephant populations, agrees Koch—but it would require a detailed isotopic map of Africa, which is a daunting project in its own right, plus several hundred dollars' worth of tests on each tusk. Furthermore, he notes that in his study, isotope ratios in molars were more variable than in bone. Tusks grow faster than teeth and are likely to be even more variable, he says. The true test, using tusk microsamples from Amboseli and elsewhere, has yet to be done. For now, says Koch, the message is that the technology is not yet ready to support a resumption of ivory trade.

–Elizabeth Culotta