events that regulate blood coagulation," Cunningham says. "It's sensible to make that argument for the brain, too."

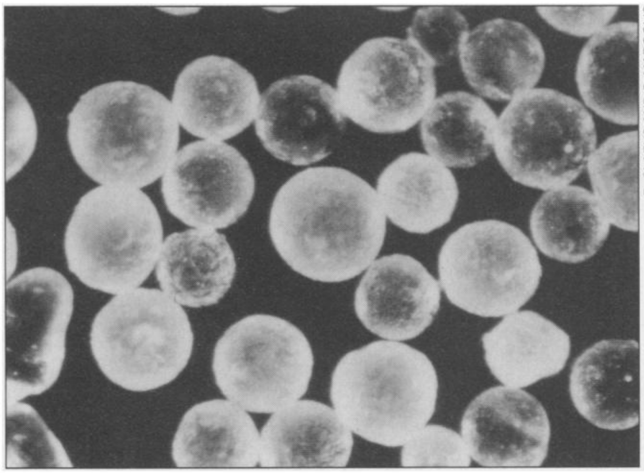
Whether Alzheimer's researchers generally will find that the suggestion that one of their favorite molecules regulates blood clotting is "sensible" remains to be seen, however. "Making the leap that this is important in blood coagulation is a big if for me," says Sam Sisodia of Johns Hopkins University School of Medicine, who studies APP secretion, among other things. He favors the more standard view that APP somehow maintains connections between nerve cells, but nonetheless concedes that it might have more than one function as so many of the body's other proteins do.

While the California group's proposal may shed some light on APP's normal role, it doesn't help explain how it contributes to Alzheimer's pathology. But as Cunningham points out, maintaining the cerebral blood flow is also important for brain function. A deficiency of a clotting inhibitor might predispose an individual to stroke, for example. All in all, the protease nexins, whether as clotting regulators or maintainers of connections between nerve cells, may have a great deal to do with maintaining the brain's health.

– Jean Marx

EVOLUTION

Another Impact Extinction?


P. CLAEYS AND S. MARGOLIS

Relics of catastrophe. An asteroid or comet impact spewed these 300-micrometer glass beads 367 million years ago.

At first, they hardly looked like relics of a global cataclysm. The microscopic beads of glass appeared to be little more than a curiosity when Jean-Georges Casier stumbled across them in 1987 among the tiny marine fossils he had extracted from 367-million-year-old rocks in Belgium near the French border. Casier, who works at the Royal Institute of Natural Sciences of Belgium, showed them to a Belgian colleague, who pronounced them to be mere volcanic glass.

That was that—until Casier opened the 29 March 1991 issue of *Science*, where a paper by geochemists Philippe Claeys and Stanley Margolis of the University of California (UC), Davis, and Frank Kyte of UC, Los Angeles, featured spherules that looked strikingly like Casier's. Instead of volcanic glass, though, the paper described them as debris typical of huge asteroid or comet impacts, such as the one 65 million years ago at the geologic boundary between the Cretaceous and Tertiary periods, which marked the end of the age of the dinosaurs. Casier's spherules, though more than 300 million years older, roughly coincided with another of the half-dozen mass extinctions of the past 500 million years—the one marking the boundary between the Frasnian and Famennian stages. That was when most existing species of corals and many other bottom-dwelling marine species went extinct. Could he have stumbled upon another killer impact, Casier wondered?

To test the possibility, Casier teamed up with Margolis and Claeys, and in a poster at this month's American Geophysical Union meeting in Montreal the trio presented evidence that the spherules were indeed formed when molten rock splashed from a giant impact crater. For one thing, the shapes were the same ones—mostly simple spheres but also fused spheres, dumbbells, and teardrops—that show up in the glass beads, or microtektites, from known crater debris. Laboratory analysis of the Belgian spherules also revealed the low water content and extremes of elemental compositions typical of Cretaceous-Tertiary tektites. "The distinctive compositions are impressive," says geochemist Wayne Goodfellow of the Geological Survey of Canada (GSC) in Ottawa, who has searched the F-F boundary elsewhere. "I'm excited about the Belgian microtektites."

No one is rushing to conclude that the impact caused the F-F mass extinction, however. The relative timing is still too uncertain. The F-F boundary has traditionally been located by tracing a change in the assortment of tiny tooth-shaped fossils called conodonts, all that remain of a leech-like creature. But the abundance of conodonts in any particular layer of rock is subject to the vagaries of the fossilization process. Where Casier found the microtektites, conodonts are scarce. At best, says Claeys, the group can say that their thin layer of microtektites falls within a few hundred thousand years of the conodont-defined F-F. That's quite close for events more than one-third of a billion years old, but not clearly coincident.

So far, workers searching for microtektites at other sites, where the F-F boundary is often more sharply defined, have come up empty-handed. But Goodfellow and sedimentologist Helmut Geldsetzer of the GSC in Calgary are hoping that a different impact indicator may help them tie the impact to the extinctions. In the Montagne Noire region of southern France, Goodfellow and Geldsetzer recently detected enhanced concentrations of the element iridium in a 4-centimeter-thick layer right on a well-defined F-F boundary. Iridium, which is scarce in Earth's crust but abundant in asteroids and comets, turns up in most Cretaceous-Tertiary boundary deposits. Still, the element is not as unequivocal a marker of impacts as microtektites. An iridium-enriched layer found in 1984 near the F-F boundary in western Australia has been dismissed as more likely to be the work of iridium-concentrating microbes than of an impact.

But Goodfellow and Geldsetzer believe their French iridium anomaly is more promising than the Australian find ever was. The concentration of iridium at the French site is far higher than in western Australia, they say, and is comparable to Cretaceous-Tertiary concentrations. And they argue that the ratio of iridium to ruthenium is just what's expected of an asteroid or comet. Whether the Canadians have found a true impact signature could become clearer as they search the iridium layer for microtektites and shocked minerals, another sign of a large impact.

Meanwhile, Claeys and Margolis are on the trail of a different F-F mystery: where the impact struck. They are pursuing the possibility that their microtektites were splashed from a known crater, possibly the nearby Siljan crater in Sweden, which is about as old as the F-F boundary.

Without an impact crater or an indisputable link to the extinction, the signs of impact at the F-F boundary fall in roughly the same category as the shocked minerals recently discovered at the 202-million-year-old Triassic-Jurassic mass extinction (see report in the 24 January *Science*): suggestive, but by no means the clear signature of a killer. But if the case for impact-caused extinction strengthens at either boundary, the long-discussed possibility that repeated killer impacts shaped the history of life may look more compelling.

–Richard A. Kerr

ADDITIONAL READING

• P. Claeys *et al.*, "Microtektites and Mass Extinctions From the Late Devonian of Belgium," *EOS Trans AGU* 73, 328 (1992).