sity of Pennsylvania. "He was the kind of postdoc that you dream about—motivated, skilled, and someone who knows exactly what he wants," recalls Penn's Larry Kricka, a professor of pathology and laboratory medicine. "He also understood the value of exploiting intellectual property. And that's key to what he's trying to do at the new center."

Cheng left Penn for the San Diego–based Nanogen, where he helped develop a bioelectronic chip that isolates and purifies DNA and RNA from a whole blood sample. But after 3 years there he wanted to be his own boss and to operate on a larger scale. So in early 1999 he returned to China as a full professor at Tsinghua, which gave him a generous budget to set up an R&D center there. "He's had tremendous support that would make many of us in the U.S. jealous," says Peter Wilding, a professor of clinical chemistry at Penn whose work over the past decade on capillary electrophoresis helped to lay the groundwork for "PCR-on-a-chip" technology.

Within months, Cheng had persuaded Tsinghua to back Aviva, which he set up down the road from his former employer. Its research staff has focused on technology that prepares the samples for analysis—the first and most difficult step in the process. In October the company unveiled its latest technology at an international biochip symposium in Beijing—a multiforce active biochip that uses micromagnets, acoustic, and dielectrophoretic forces to help isolate the material to be analyzed. In a clear demonstration of its significance, the meeting was a subset of an international conference opened by Chinese President Jiang Zemin. University officials have insisted that he spend half his time at Aviva, Cheng says, to make sure that it remains on track in licensing new technology and developing products.

Some scientists wonder if Cheng's new venture will be nimble enough to keep up with the latest technology, however. "It's not a good idea to develop the biochip industry by injecting a large amount of money in start-up funds," says Lu Zuhong, head of a biochip laboratory at Southeast University in east China's Nanjing. The key to commercial success is not a large laboratory with lavish facilities, Lu says, but quickly converting a research finding into a marketable product.

Other scientists worry that Cheng may be spreading himself too thin. The national center has targeted half a dozen areas, ranging from refining the processes underlying any microlab on a chip to creating an implantable chip for therapeutic and monitoring purposes. But Hu Gengxi, a research professor at the Shanghai Institute of Cell Biology of the Chinese Academy of Sciences, thinks that it would be better to focus on one or two promising areas.

Cheng defends his approach, saying that one goal of the center is to "provide a more solid basis for development" of the Chinese biochip industry. Its successful dissemination of new technologies, he adds, "will benefit other, smaller Chinese companies" that might otherwise not have access to them. And Cheng says that a generous budget offers him the freedom to tackle several research questions simultaneously. Cheng also says that he'll try to minimize the potential conflicts of interest stemming from all the hats he is wearing. "Although I am chief technology officer for two companies, the ideas generated during my work and discussions in the United States will belong to the American company, while the national center will benefit from my ideas and service in Beijing."

In tackling these and other issues, Cheng says there are few domestic models that he can follow. "We are making it up as we go along," he confesses. But he wouldn't have it any other way. "We need to find the right approach that works for China," he says. "You can't simply copy Western practices."

–DING YIMIN

Ding Yimin is a reporter for *China Features* in Beijing. With reporting by Jeffrey Mervis.

PROFILE
DICK MOL

'Sir Mammoth' Leads Charge To Uncover Ice Age Fossils

Dick Mol may be an amateur, but he's had more success than most professionals in his chosen field of paleontology

ON THE EASTERN SCHELDT, THE NETHERLANDS—In the driving rain on a recent autumn day, several slicker-clad men and women stand on the deck of the Dutch mussel cutter *ZZ10*. A clanging winch hauls up a dredge net and swings it over the side. Out spills a marine cornucopia: loads of brittlefish and mussels, a few flounder, the odd worm with iridescent bristles. The crew paws through the writhing mass, pushing aside the living creatures in search of something that died ages ago.

The Tiglian-type sediments in these waters off Zeeland date from 1.6 million to 1.8 million years ago, when today's estuary was dry land inhabited by southern mammoths, squat mastodons, giant deer, and the saber-toothed cats that preyed on them. Every year for the past half-century, a gang of scientists, amateur enthusiasts, and local officials has spent a day dredging for new fossils from this exotic menagerie to honor the fishers who spend their lives on these waters hauling up relics of a long-lost era. This time, one small bone fragment defies identification—at least until one of the sharpest eyes aboard the *ZZ10* comes over to take a look. Stocky, blond Dirk Jan (Dick) Mol picks up the black bone, so heavily mineralized that it emits a sharp ping when tapped, and within a few seconds concludes that it's a fragment of a foot bone from a southern mammoth—not bad for a customs officer at Amsterdam airport. But not surprising: As paleontologist Jelle Reumer, director of the Natural History Museum in Rotterdam, explains, Mol is "Mr. Mammoth."

No other country, perhaps, embraces amateur paleontology as warmly as the Netherlands does. "Vertebrate paleontology as an academic subject now hardly exists here," says Reumer, who notes that hot fields such as genetics tend to get the few new academic positions created at universities in his country. "Amateurs help fill that gap." Mol may be the most accomplished of the amateurs, says John De Vos, a curator at the National Museum of Natural History in Leiden: "He knows every mammoth specimen in Europe. He's crazy! He's obsessed!"

Catching on. Dick Mol enlists Dutch fishing vessels in his hunt for fossils.

CREDIT: MUTSUMI STONE

The 45-year-old Mol is also a celebrity. As scientific coordinator of a major expedition that's gathering the remains of woolly mammoths and other Pleistocene fauna from Siberia's Taimyr Peninsula, Mol has been featured in a documentary on the Discovery Channel and in a sequel to appear next March. The work has brought him international recognition for his studies on quaternary paleontology, the study of the Pleistocene and today's Holocene Epochs. He's even earned a knighthood from Queen Beatrix.

Mol's fascination with fossils was kindled when a grade school geography teacher in his hometown of Winterswijk showed him a collection of sea urchin fossils dating from tens of millions of years ago. As a teenager, he went with his uncle to the Leiden Museum, where curators showed him backroom collections of mammoth bones gathered from the North Sea. "I decided from that moment on to collect the remains of ice age mammals," he says.

The oldest of nine children, Mol could not afford to attend university. But his decision to join the customs service in 1974 proved to be a major boon to his avocation. That same year, the Netherlands implemented the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which gave customs officers sweeping interdiction powers. Mol, who trained as a CITES specialist, spends so much time on the job studying bones and interacting with pros that he doesn't regret missing out on an academic career. Nor has he ever found a colleague from academia reluctant to collaborate with him. "Many scientists don't even know that I'm a customs officer," he says.

His employer has also benefited from his passion. A traveler arriving from Hong Kong once declared that an ornate sculpture of a Chinese god was carved from woolly mammoth ivory. Because mammoths are extinct, their parts are not protected under CITES, unlike those of living elephants. "I told him, 'I do not believe you, and I'll tell you why,' " Mol recalls. The object was clearly carved from a straight tusk without any cracks, he says—a dead giveaway, considering that mammoth tusks are curved and even the best preserved tusks from the Siberian permafrost have cracks. Mol gave the chagrined man a choice: Either ask a court for a radiocarbon date or pay a steep fine. The would-be smuggler paid up.

As Mol's self-taught acumen grew, he started to see things that professionals had missed. He learned from fragments snared in fishing nets that the North Sea faunal assembly features three mammoth species, illustrating that the sediments encompassed millions more years than previously thought. His work has generated dozens of scientific papers and collaborations with top academic researchers. He was also the first to find a flaw in a highly publicized 1993 report in *Nature* claiming that the freshest mammoth remains ever found—bones of individuals that died only 3800 years ago on Siberia's remote Wrangel Island—belonged to dwarf male mammoths. After seeing the bones, Mol realized they were not dwarfs but old female mammoths, which are smaller than their male counterparts; that left bragging rights to the only true dwarf mammoths known from the fossil record to the Channel Islands off California.

Over the years, Mol has amassed about 15,000 specimens in his suburban townhouse.

Obsessed. A grade school teacher kindled Mol's lifelong passion for paleontology.

His most beautiful trophies—including exquisitely preserved mammoth tusks, teeth, and jawbones and a Pleistocene musk ox horn sheath—litter the bookshelves and floors. The rest, cleaned, ID'd, and numbered, fill some 600 footlocker-sized Styrofoam boxes. When Mol's daughter moved to The Hague a few years ago, her room was soon taken over by bones. "I'm waiting for my son to leave as well," he says with a laugh.

Mol's big break came in August 1998 with a call from Bernard Buigues, a Frenchman who runs a Paris-based tour company specializing in trips to the North Pole. Earlier that year, Buigues said, he had discovered the remains of a woolly mammoth at a site on the Taimyr Peninsula, far above the Arctic Circle. Buigues wanted Mol's help to excavate the mammoth. The result was a remarkable collaboration involving two dozen scientists from around the world.

Buigues had planned a traditional excavation that would blast the permafrost with hot water in summertime. "But that would have destroyed the scientific information," says Mol, who persuaded the Frenchman to undertake a riskier endeavor: chiseling out the chunk of permafrost containing the remains and airlifting the block to a cold room for study (*Science*, 29 October 1999, p. 876). The mammoth is now being thawed slowly so that any flesh in the block can be recovered still frozen and associated plants, pollen, and insects can be retrieved. "It will be the first time that scientists have access to materials in which the frozen chain has not been broken," Mol says.

Last summer, Buigues, funded royally by the Discovery Channel, mounted the largest expedition ever to collect mammoth remains in Siberia. The researchers hope to shed light on the shifting mosaic of species, from mammoths and woolly rhinos to saiga and voles, that lived throughout the late Pleistocene and early Holocene. They also hope to test a provocative theory that mammoths and many other large animals succumbed not to climate change or human hunters—as most researchers think—but rather to an apocalyptic plague.

Particularly noteworthy is the expedition's leadership. While the chief scientist is renowned paleoanthropologist Yves Coppens, who co-discovered the Lucy hominid bones, the key decisions are made by two amateurs. Buigues oversees logistics, and Mol sets the scientific agenda with pro forma approval from Coppens, who has visited the site but has not participated in the fieldwork. Mol's stewardship of the program—and his avowed skepticism toward the possibility of cloning the mammoth—impresses other expedition members. "Dick is a very, very smart guy. But because he never got a position in academia, he has to wear this big 'A' for amateur on his forehead," says mammalogist Ross MacPhee. A curator at the American Museum of Natural History in New York City, MacPhee and Preston Marx of the Aaron Diamond AIDS Research Center in New York City proposed the plague theory 3 years ago. MacPhee is impressed with the openness with which Mol has conducted the program, including a plan to distribute mammoth remains to anybody who submits a serious research proposal.

Mol's most lasting legacy may be the credibility he lends to a thriving community of amateur paleontologists. Last May, when Mr. Mammoth became Sir Mammoth, the honor brought practical results. "I asked my boss if it would be possible to get some extra holiday to spend in Siberia with the expedition," says Mol, who had already used up his generous allotment of 3 months annual paid leave. "He said, 'Of course. How much time do you need?' "

–RICHARD STONE

CREDIT: MUTSUMI STONE