

Fortune

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LIGHTNING BUGS

High-voltage hobbyists make huge sparks, shrink coins, and crash computers from a distance. Yes, it's a guy thing

Ivan Amato

LAST MAY, IN A DARK townhouse basement in Cinnaminson, N.J., Dan McCauley, a 32-year-old radar engineer with Lockheed Martin, became Zeus.

With his hand on the dial of a Variac, a souped-up version of a power controller for toy trains, McCauley cranked up the juice feeding into what looks like a mushroom-shaped technoprop from Frankenstein's laboratory. An inch-high fountain of sparks spewed from a wire nub that McCauley had taped to the toroidal top of the device, known as a tesla coil. Another twist of the knob, and the sparks grew longer and fatter into little-tyke lightning bolts.

When he cranked the dial a bit more, all hell broke loose. Like an angry snake held by its tail, a continuously morphing spark lashed out, nipping the ceiling, a camera tripod, whatever it could reach. All the while, microthunder filled the basement. Any neighbor within earshot must have thought the condo complex was about to blow.

McCauley was buzzing. This successful test run meant he was likely to do well in August when he was slated to unveil his state-of-the-art tesla coil at an annual gathering of about 60 high-voltage enthusiasts. Like community-theater troupes and dog-show aficionados, HV hobbyists share a passion--only theirs mixes a NASCAR-like craving for powerful machinery

with an MIT-style affection for geekery.

After a minute of playing Zeus, McCauley dialed the Variac down and flicked on the lights. There was a nose-wrinkling smell. "Ozone," McCauley said.

That is the smell of success for McCauley and his loose fraternity, for whom making big sparks simply is one of life's necessities. "Once you build a coil, you want to build a bigger one," he says. "It's a disease."

Hero to many coilers is Nikola Tesla, the Serbian-born turn-of-the-20th-century pioneer in alternating-current (AC) power transmission and a fearless experimenter with high voltage. The lightning-making coils that go by his name have been emulated in small and big ways for over a century.

In recent years the HV community has been diversifying. There are the coin shrinkers, who use high voltage to generate magnetic fields muscular enough to shrink quarters into sub-dime dimensions. There's the "fusor" crowd, which aims to achieve fusion power using tabletop high-voltage particle accelerators. And on the darker fringes are those who channel their mostly homespun know-how into building electromagnetic rail guns that propel metal slugs not even Keanu Reeves, invoking Matrix time, could dodge, or high-energy radio frequency (HERF) guns that are to electronics what a bull is to a china shop.

It's all about shock and awe. To cavort with high voltage is to handle snakes, walk on fire, chase tornadoes. It's the way some technophiles choose to honor the awesome power of nature.

"When I see a manifestation of electrical power, like a lightning strike, or if my rail gun fires, it's a thing of beauty," says Sam Barros, a 23-year-old electrical-engineering student at **Michigan Technical University** in Houghton, Mich. Barros's love affair with electricity began at the age of 7, when he bent a wire into a U and stuck the ends into an electric socket. The wire exploded and blackened the wall. His parents were appalled. "It was at that moment that I started really admiring electricity," Barros says.

Like most HV hobbyists, Barros has made tesla coils. At the heart of a typical coil are about a dozen thick windings surrounded by a secondary spool-like coil that can have thousands of windings. Atop the nested coils is a metal toroid, sometimes made on the cheap by wrapping a ring of corrugated vinyl drainage tubing with aluminum foil. When a voltage is applied to the primary windings, a much higher voltage is induced in the secondary coil, shunting charge to the toroid. When that charge builds up enough, it overcomes the air's insulating properties and strikes out with a spark. It's like filling a balloon with a charge instead of air. The little wire McCauley tapes to his toroids functions like a hole in a balloon, opening a pathway for

electricity. McCauley says his solid-state coil probably ups the 110 volts from the wall to hundreds of thousands of volts.

Barros has been pushing the boundaries of the HV community by working on an electromagnetic rail gun. He used to do this work in his parents' basement. Now he's getting more official, having secured lab space at MTU, the backing of a research advisor, and a donation of capacitors from the company Cornell Dubilier.

Lining the two-foot-long rail is a gantlet of coils connected to the capacitors, each of which stores electrical energy like a battery but delivers the stored charge all at once. With the flick of a switch, Barros initiates what might be considered a supremely fast electromagnetic variant of peristalsis. The capacitor-coil combos generate a series of intense magnetic fields, which propel a projectile down and out of the rail with a blaze of white-hot sparks, a head-jerking bang, and the smell of ozone. On the receiving end are aluminum cans or sheets of plywood in front of a cinder-block laboratory wall. He can shoot finger-length metal slugs and, with some modification, even mostly nonmetal projectiles, including aluminum-backed Teflon slugs.

Cut from the same cloth as Barros is Rostislav Persion, a Ukrainian-born, twentysomething wunderkind halfway through an electrical-engineering program at the State University of New York at Stony Brook. As a kid, he built a toy electric chair. On the home page of his website, titled Voltage Labs, is a picture of a nuclear mushroom cloud and the motto "Applied Science for Military Applications." May Slava, as

Persion likes to be called, never turn to the dark side.

In high school Slava's attention turned to HERF gizmos after he learned about EMPs, or electromagnetic pulses, which are generated by nuclear explosions. With no nuclear weapons readily available, Slava figured out how to use the magnetrons inside microwave ovens to build his own HERF weapons. The gadgets are essentially bright lamps, only they emit invisible microwaves from a cone-shaped antenna instead of visible light from a bulb. Since wires and chips can pick up microwaves, HERF guns can wreak electrical and electronic havoc. Plenty of classified R&D is devoted to developing offensive and defensive electromagnetic technologies like HERF guns.

When Slava flicked on his first homemade HERF gun, the computers in his house crashed and had to be rebooted. "All the speakers were buzzing, and the phones wouldn't work for 20 minutes," he adds. It was a moment of teenage triumph.

Last year Winn Schwartz, an organizer of information-warfare meetings, invited Slava to a conference in Washington, D.C. After warning those in the audience to leave their computers outside the room, Slava flicked on his HERF gun. A sacrificial computer across the room crashed instantly. "His demonstration blew people away," says Schwartz. Slava's goal now is to finish school and work as a military researcher.

McCauley already has a job. What drives him these days are gatherings called teslathons. One of the most prestigious, invi-

tation-only teslathons takes place annually in late August near Rochester, N.Y. "I live for these," says McCauley, who was thrilled when he got his first invitation two years ago. Teslathon organizer Ed Wingate, a retired toolmaker for Kodak, describes the experience as "being in a building with a contained thunderstorm." For a special thrill, Wingate built a "cage of death," in which a person can stand and experience lightning up close (the cage shunts all the electricity into the ground).

On Aug. 20, at the latest Rochester tesla-thon, McCauley was able to show off his coil. In a shed, with heavy rain pelting the metal roof, McCauley cranked up his Variac. An angry spark lashed out, this time stretching beyond five feet. "Everyone was completely stoked," says McCauley. Bert Hickman, a coin shrinker from the Chicago area, concurs. "What we were seeing there was the state of the art."

It was a transient spark of glory, of course. For HV enthusiasts, no spark is big enough.

IVAN AMATO's latest book is *Super Vision: A New View of Nature*.

"Once you build a coil, you want to build a bigger one. It's a disease."

GRAPHIC: COLOR PHOTO: CHERYL WINGATE TESLA PHOTO :N/C, Ed Wingate's tesla coil shoots homemade lightning at the cage of death.; B/W PHOTO: PHOTORESEARCHERS, Nikola Tesla, the original high-voltage junkie

The Detroit News

October 6, 2004 Wednesday No dot Edition

SPORTS; Jim Spadafore; Pg. 5E

MAC schools going through growing pains

Jim Spadafore

If fans at Central, Eastern and Western Michigan are a little restless these days it's understandable.

When are the three going to make another run for the Mid-American Conference championship? Better yet, how about a winning record? The three teams have each had losing seasons the last three years.

Eastern Michigan hasn't won a MAC championship since 1987.

Central Michigan hasn't won the MAC since 1994.

Western Michigan won the MAC West Division in 1989 and 1990.

Hold on, though. The outlook is promising. Believe it. All three teams are playing a lot of freshmen and sophomores this season. CMU is playing 24 freshmen or sophomores among its 44-player two-deep, EMU 23 and WMU 20. The Broncos have the MAC's No. 1 recruiting (freshman) class, according to the Phil Steele College Football Preview.

It may be too late to save Coach Gary Darnell's job at Western Michigan, but there's still time for the Broncos (1-3, 0-1) to turn it around, starting with Saturday night's game against visiting Toledo.

"Every year we have a goal to compete for the West Division title," WMU Athletic Director Kathy Beauregard said. "Our first MAC game (a 41-14 loss to Ball State) didn't go our way, but there's a lot of football to be played. The MAC is a great con-

ference, but our expectations this season were to compete for the title."

Central Michigan and Eastern Michigan have new coaches in Brian Kelly and Jeff Genyk, respectively, so they have some time to turn their programs around.

Central Michigan is the best shape to do it the quickest because it has some strong young players like sophomore running back in Jerry Seymour and sophomore wide receiver Damien Linson.

Just as importantly, the Chippewas have a coach who knows how to build a winning program in Kelly, who guided Grand Valley State to consecutive Division II national championships. The Chippewas (2-2, 1-0) can make a big statement Saturday when they face Bowling Green at 1 p.m. in their homecoming game.

Eastern Michigan (1-4, 1-1) looked like it was making progress this season under Genyk, but the Eagles lost their last two games to Division I-AA Eastern Illinois and Idaho. They were games the Eagles should have won.

But it's going to take Genyk time to transform a losing mentality into winning. If he can do that at Northwestern, he should be able to change the mind set at EMU.

So, the future looks pretty good for all three schools. But it's going to take time.

MAC bowl picture

MAC Commissioner Rick Chryst has been working diligently to give the conference another bowl to go with the Motor City Bowl and GMAC Bowl, and it looks like it could one in Toronto. Don Loding, director of operations for the Motor City Bowl, is heading a group to have the MAC part of a new bowl at the SkyDome in Toronto.

"It's in the early stages and we have a long way to go, but I feel confident we will have a bowl there in 2005," Loding said.

Loding said early talk has the MAC runner-up or third-place team playing the Big East's third-, fourth- or fifth-place finisher in Toronto.

Notable

Senior Andrew Terry rushed for a Division II-record 410 yards, on 38 carries, Saturday night in leading Ferris State (5-1) to a 35-7 victory over Findlay. Terry scored on an 82-yard run. He broke the record of 405 yards set in 2000 by Alvon Brown of Kentucky State against Kentucky Wesleyan.

... The Great Lakes Intercollegiate Athletic Conference has four teams ranked in the top 20 ? No. 1 Grand Valley State (5-0), No. 12 Northwood (6-0), No. 13 Saginaw Valley State (4-1) and No. 17 **Michigan Tech** (5-0).

A date to remember: On Oct. 16, GVS plays at SVS at noon and Northwood is at Tech at 1 p.m. And don't forget the Nov. 6 game matching Grand Valley State against **Michigan Tech** at Michigan Stadium.

The Associated Press State & Local Wire

October 5, 2004, Tuesday, BC cycle

Briefs from the Upper Peninsula

MUNISING, Mich.

For more than three decades, engineers have studied deterioration of the complex that houses Munising's public works and fire departments.

City officials now are taking another look as they ponder whether to upgrade the aging structure, move or rebuild elsewhere.

The city commission recently tried to combine options by buying the former armory at the Munising Township Industrial Park and building new storage structures at the facility. That would consolidate public works operations in one location away from downtown.

The city's fire hall would remain at the current location, with hopes of building a new structure there in years to come.

Critics say the existing facility could be cleaned up and still used efficiently, at a cost savings to the city.

Last month, voters rejected a roughly \$1 million bonding proposal to purchase and upgrade the industrial park building.

The city now hopes to repackage the idea - dropping a plow truck purchase from the plan - and consider moving forward with its consolidation plans. The city commission is expected to discuss the issue Wednesday.

HOUGHTON, Mich. (AP) - A man who pleaded no contest to sexually assaulting a 14-year-old girl has been sentenced to more than three years in prison.

Brandon Lee Rassmusson, 23, of Calumet, was given a term of three years and two months Monday in Houghton County Circuit Court.

Police said Rassmusson assaulted the girl as they went for a walk the night of July 31.

He originally was charged with first-degree criminal sexual conduct, a felony punishable by up to life in prison. He pleaded no contest to the reduced charge in a plea agreement.

He recanted briefly and demanded to take a polygraph test, which he failed, Prosecutor Doug Edwards said.

HOUGHTON, Mich. (AP) - A researcher at **Michigan Tech University** has received a \$255,000 grant from NASA.

Greg Odegard, assistant professor of mechanical engineering, develops computer models for tiny materials that could result in stronger, lighter aircraft.

Odegard creates the models to predict the strength of nanomaterials. One nanometer is equal to one-billionth of a meter.

"The materials we use, called nanotubes, are so small that we must rely on computer models to determine their stiffness and strength," Odegard said Tuesday. "It is very expensive to do this through experimentation."

Scientists typically add these small nanoparticles to other materials to take advantage of a specific property - for example, strength or resistance to corrosion.

Odegard focuses on polymers - or plastics - that are extremely lightweight, yet can be combined with other materials to add strength.

Potential benefits of the research include improved structural components of aircraft, such as the outer skin and support structure of wings and the outer surface of the fuselage, Odegard said.

Odegard started his computer modeling work four years ago as a scientist at NASA's Langley Research Center in Virginia. He joined the **Michigan Tech** faculty this past August.

BESSEMER, Mich. (AP) - A major piece of the Gogebic County Jail expansion project fell into place Monday with the announcement that money had been set aside for a low-interest loan.

"We got notification from the U.S. Department of Agriculture that our loan application has been approved," said Sheriff Larry Sanders.

The loan application was for \$4.1 million. An initial tax levy of .66 mills would be required. That levy would decline over the term of the loan.

"Of course, we still need voter approval for a new jail. Right now we're looking at a possible millage vote in May," the sheriff said.

USDA Rural Development describes project as including a 20,000-square-foot facility with a 45-bed jail, department offices, holding cells and a security garage.

The loan is being offered at a fixed rate of 4.75 percent over 30 years.

The Associated Press State & Local Wire

October 2, 2004, Saturday, BC cycle

Michigan Tech 38, Gannon 24

ERIE, Pa.

Dan Mettlach threw for three touchdowns and Lee Marana ran for two more to lead **Michigan Tech** to a 38-24 victory over Gannon on Saturday.

Mettlach connected with Brian Janesheck on a 47-yard touchdown pass in the third quarter for the Huskies (5-0, 5-0 Great Lakes). He also threw a 39-yarder to DeVon Allen with 10:49 remaining in the fourth quarter and found Allen on a 3-yard scoring pass 6:38 later. Mettlach finished 9 of 24 for 253 yards and one interception,

Darmel Whitfield was 25 of 45 for 385 yards for Gannon (2-4, 2-4). He threw TD passes of 18 and 5 yards to Donald Rose and Sam Culberth, respectively, and ran 12 yards for another score. Brendan McNicholas added a 43-yard field goal for the Golden Knights.

Marana led all rushers with 152 yards and opened scoring for **Michigan Tech** with a 41-yard run in the first quarter. The Huskies also scored on Grant Botz's 27-yard field goal in the second.

National Post

October 1, 2004 Friday Toronto Edition

Canada: SPORTS; Pg. S8

Baby steps: A litany of losses while playing U.S. college hockey may have helped Brett Englehardt prepare for his shot at the AHL

Joe O'Connor, National Post
KITCHENER

- The media relations person recognized the name, but didn't know what the player in question looked like. One of the equipment managers also recognized the name -- he had even seen it in action at the Kitchener Memorial Auditorium earlier that morning -- but he could only picture it stitched across the back of a sweater.

The coach had more insights, but not many.

"Englehardt?" said Doug Shedden, scanning down the list of players at the St. John's Maple Leafs training camp. "It's tough to keep on eye on everybody, but the one thing I have noticed is he is a big kid who skates well."

The big kid has a first name -- Brett -- and an American passport, one of only two such documents among the 30 Canadians, one Swede, and one Czech gathered in Kitchener this week, trying to either get in shape for the start of the American Hockey League season or win a job with the Baby Leafs.

Andy Wozniewski is the other American. And the 6-foot-4 defenceman knows more about Brett Englehardt than all the Canadians combined. "We played on the same U.S.

select team when we were 16 or 17," Wozniewski said. "And I remember he scored an unbelievable goal against us last year, a one-timer on the power play -- top shelf -- but he's more of a get-in-the-corners-and-grind-type player."

Englehardt's homage to Brett Hull came in the third period of a game between his **Michigan Tech** Huskies and Wozniewski's University of Wisconsin Badgers. It momentarily cut the Badgers lead to one, in a game Tech lost 4-2.

"I think we might have tied them once in my junior," says Wozniewski, "but Tech would kind of have a rough year, every year."

Indeed, Englehardt had four rough years in a row. And for three of them he was the captain of the team that went 34-99-15 during his college career.

All the losing began right after a season that saw Englehardt and his junior team, the Green Bay Gamblers, come within a game of winning the United States Hockey League championship.

"I think I learned to be a much classier player," said the 24-year old native of Sheboygan, Wis. "I mean there is no way you can accept losing -- and I

don't -- but you look at peoples' attitudes and you start to learn why some people don't win and some people do, and why some people are always winning."

Englehardt may not have enjoyed team success at **Michigan Tech**, but he has always been a quick study when it comes to hockey. His hometown is in the heart of Green Bay Packers country -- where God and football share equal billing. But football wasn't a fit for the 6-foot-1, 200-pound winger who experienced a Canadian-style epiphany at age six when he picked up a hockey stick for the first time.

"There was a little outdoor rink," Englehardt said. "I went out there for open skate, and the next day my dad came home and said he'd signed me up for hockey. After that there was no question about what I wanted to do with the rest of my life."

Englehardt would be overlooked in the NHL's amateur draft and altogether ignored by his beloved Wisconsin Badgers before accepting a full athletic scholarship to attend **Michigan Tech**. But the Huskies' struggles did not interfere with his studies. Englehardt graduated this spring with a degree in finance and was named to the all-conference academic team.

Still, instead of going straight into investment banking as he one day hopes to do, Englehardt asked his agent to make a few phone calls first. That produced a contract offer from the East Coast Hockey League's Gwinnett Gladiators and an invitation to come to Kitchener from Leafs general manager John Ferguson.

"I remember him, from before he went to college, in the USHL. He was a real hard up-and-down player with some ability to score," Ferguson said. "He has some attributes that may project to be a third- or fourth-line-type checker. But he's the type of player who is clearly going to have to make it at this level before he has an opportunity to get a sniff anywhere else."

And if Englehardt doesn't get a sniff, he will still have a chance to make a name for himself on Wall Street.

GRAPHIC: Color Photo: Andrew Wallace, National Post; Growing up in Wisconsin, where football is akin to religion, Brett Englehardt discovered hockey at a small outdoor rink.

The Associated Press State & Local Wire

September 30, 2004, Thursday, BC cycle

Upper Peninsula Briefs

MARQUETTE, Mich.

The unusual stretch of warm, sunny weather in the Upper Peninsula may be pleasant, but is creating a fire hazard.

"When it's so pretty blue in the sky, that usually means the humidity level has dropped to 30 percent or less. When it gets down that low, things dry out a little quicker, making for high fire conditions," said Randy McKenzie, fire specialist with the Michigan Department of Natural Resources office in Harvey.

Although the high-risk season is coming to an end, campers and others who build fires should remain cautious, said Robert Ziel, fire management specialist with the DNR.

McKenzie said Michigan's northern Lower Peninsula has had several wildfires this year, burning anywhere from 5 to 30 acres.

"We've been lucky here in the U.P. but we fit the bill," he told The Mining Journal for a story Thursday. "If a fire gets going and the winds are high, we could have a similar situation."

A permit is required to burn leaves and other natural materials outdoors.

MARQUETTE, Mich. (AP) - A local pioneer in women's athletics was stabbed to death in Wisconsin, authorities said.

Francine L. Malindzak, 47, of Marquette, was found dead Tuesday night at a residence in Commonwealth, Wis., a town near the Michigan state line.

The Florence County Sheriff's Department said it responded to a report of a domestic disturbance there. A 41-year-old man and a 40-year-old woman were taken into custody, deputies said.

Malindzak was assistant coach of the Marquette Senior High School ski teams and head coach of the Marquette Mountain Race Team, a youth skiing program that involves about 150 skiers ages 6 to 18 in the central Upper Peninsula.

"She gave a tremendous amount of time to hundreds of young people in our local ski community," Derek Anderson, head coach of the Marquette High ski teams, told The Mining Journal.

She is a member of the sports hall of fame at Northern Michigan University, where she was an All-America skier and earned varsity letters in volleyball, basketball and track.

Malindzak once ranked 17th in the United States by the Federation International de Ski.

After graduating from college in 1983, she excelled in the sport of luge, finishing first in the North American Championship and spending six weeks in Europe on the U.S. luge "B" team.

HOUGHTON, Mich. (AP) - The faculty at **Michigan Tech University** decided Wednesday to join a union.

The vote to align with the American Association of University Professors was 152 in favor and 134 against. The AAUP has more than 45,000 members at colleges and universities across the nation.

A local chapter of the union will represent the faculty in collective bargaining.

Other universities in the state that have unionized include Northern Michigan, Eastern Michigan, Western Michigan, Wayne State and Oakland University.

Over the past decade, faculty have had a diminishing role in academic, professional and fiscal policies that affect them, said Bruce Barna, a chemical engineering professor and president of the local AAUP chapter.

"We believe the vote indicates the faculty's desire to have a voice (in) these matters," he told The Daily Mining Gazette.

Michigan Tech President Glenn Mroz said the university respected the faculty's decision and would work with the union.

HOUGHTON, Mich. (AP) - A man has been charged with slashing the throat of a 92-year-old man, who survived the attack.

Paul Moilanen, 32, of Calumet Township, was arraigned Thursday in Houghton County District Court on a charge of with assault with intent to rob. He also was charged separately with assault and resisting arrest in a bar fight.

Police say Arnold Landstrom of Houghton was attacked Tuesday as he sat in his car in the local Wal-Mart parking lot. They say a man approached him, demanded his wallet, and cut his throat after he refused.

Landstrom underwent surgery at Portage Health System, where he was listed in good condition Thursday.

MARQUETTE, Mich. (AP) - A federal magistrate has ordered Thomas D. Teeple to remain in custody in a fatal stabbing at the Bay Mills Indian Community reservation.

U.S. Magistrate Judge Thomas P. Greeley on Wednesday ruled there was enough evidence to detain Teeple in the death of Jason Lyons on a murder charge.

Teeple, 27, of Brimley, was arrested after Lyons, 23, was killed on Sept. 10.

Federal prosecutors will present evidence to a grand jury, which will decide whether to return an indictment.

Lexington Herald Leader

September 30, 2004 Thursday

Kentucky: CITY & REGION; BRIEF; Pg. c10

LONG NECK A HUNTING TOOL

It's possible that long, skinny necks helped ancient marine beasts snag their prey, a new study shows.

Paleontologists have long puzzled over the bizarre necks of protosaurs, a group of extinct reptiles. In some cases, their necks were nearly twice as long as their bodies. A well-preserved fossil from China could help explain it all. Chun Li, a paleontologist at the Chinese Academy of Sciences, recently unearthed the 230 million-year-old fossil and named it *Dinocephalosaurus*, or "terrible-headed lizard."

The tiny head and long neck would have made snatching dinner easy, Li and colleagues reported last week in *Science*. The reptile could have swum near its prey, hiding its massive bulk by snaking its unimpressive head out in front. Then it could have struck quickly.

GERMS FOUND

Life is where you look for it, even under a rock.

Turn over a rock in a polar desert and you might find hordes of bacteria, scientists have found. The critters somehow manage to survive on trapped moisture and sunlight that filters in from the edges and through cracks. And the bacteria are tough; they appeared nearly everywhere scientists looked. In the Canadian high Arctic,

where plants cover just a little more than 1 percent of the landscape, bacteria were found beneath 95 percent of the rocks.

The discovery, announced in last week's *Nature*, shows how life is tougher and more resilient than anyone had thought.

MISSION EXTENDED

The Mars rover missions have a new lease on life, scientifically and bureaucratically speaking.

The two robotic explorers have resumed limited activity after a period of unreliable radio communications, and NASA has extended financing for another six months of operation, if the machines can hold out that long.

By January, if the two machines are still functioning after a year on the planet, daily operations will resume.

THEORY DEBUNKED

A recent series of experiments in the Alaska tundra have contradicted the theory that, as temperatures rise, tundra ecosystems will flourish and store carbon underground, slowing the pace of global warming.

Five researchers from the University of Florida at Gainesville, the University of Alaska at Fairbanks and the Marine Biological Laboratory

in Woods Hole, Mass., have found that, over the course of 20 years, deliberate fertilization led to a net loss of about 25 percent of the carbon in the tundra soil, or 4.4 pounds of carbon for every 10.8 square feet.

The researchers, led by Michelle C. Mack from the University of Florida's botany department, published their results in the journal *Nature*. They said that high-latitude warming could accelerate carbon loss from soil, "causing a net loss of ecosystem carbon and a positive feedback to global warming."

Wendy M. Loya, an ecologist at **Michigan Technological University** who wrote an accompanying article, said carbon stored in the soil of northern Arctic and sub-Arctic ecosystems "equals two-thirds of the amount presently found in the atmosphere." Given that these areas are most vulnerable to warming, she said, if they start releasing large amounts of carbon into the air in future decades, "it's a huge deal."

RADICALS FREED

Chlorophyll is essential for life on Earth. It's the substance that allows green plants to capture energy from the sun and convert it to chemical compounds, mostly sugars, in photosynthetic plants. It's perhaps not surprising that such an amazing reaction is a potentially hazardous one.

Seeds germinating underground make a precursor compound, called protochlorophyllide, that is converted into chlorophyll as part of the complicated assembly of "photosynthetic units" that occurs once the seedling emerges into the light. The danger lies in the fact that the precursor, left to wander freely around a plant cell, can capture light energy but can-

not convert it into stable, useful compounds. Instead, it dissipates the energy in tissue-destroying "free radicals," something like setting off a crate of firecrackers. This causes bleaching of plants and sometimes death.

In the current issue of the journal *Science*, researchers at the University of California at Berkeley and several other institutions shed light on how

emerging plants keep this from happening.

Peter H. Quail, Enamul Huq and their colleagues identified a gene, *pif1*, that directs the germinating seed to make a protein that strictly limits production of the dangerous precursor. It appears the *pif1* gene is regulated by activation of the light receptors in the photosynthetic assembly.

Lightning Bug (ãf©ã,ªãf^ãf·ãf°ã,°Â·ãfã,°?, Raitoningu Bagu) is an unused kaiju from the 2007 Godzilla game, Godzilla: Unleashed. Modeler/Animator Will Short described the monster's abilities: "The Lightning Bug is a genetically-engineered cyborg developed from a host of insect DNA and grafted with a multi-alloy chassis by a hostile alien race. Lightning Bug's design was a combination of the armor from EVA-01 of NEON GENESIS EVANGELION fame and the bio luminescent appearance of the Drej from TITAN A.E

Lightning Bug may refer to: A firefly. Photinus (beetle). Photuris (genus). Pyractomena. Reflex Lightning Bug, an American kit aircraft design of the 1990s. Ryan Model 147 Lightning Bug, an unmanned aerial vehicle. Lightning Bug (comics), a Marvel Comics character. Lightning Bug (film), a 2004 horror film by writer/director Robert Hall. Lightning Bug (novel), a 1987 novel by American author Donald Harington. The Lightning Bug is a critter which spawns only in the Hallow biome. It can be damaged by enemies and the player, which usually leads to their death. Lightning bugs spawn during the night but are rarer than fireflies . They can be caught with a Bug Net to be carried around and released later, put inside a bottle to be used as furniture and light source, or used in crafting a firefly statue. The bottled lightning bug is animated and moves inside, and cannot be released once crafted.