## Ancient animals got a rise out of oxygen

If today's insects scare you, consider the Goliath flies that ruled the skies during Earth's Carboniferous period 300 million years ago. Some souped up dragonflies had wingspans rivaling those of crows. Mayflies grew to sparrow size. On the ground, silverfish, scorpions, and other arthropods reached epic dimensions.

Blame it on the air, says a controversial new theory. A team of physiologists and biomechanics experts hypothesizes that elevated concentrations of oxygen in the Carboniferous atmosphere helped some invertebrates evolve bodies much larger than those seen today.

"Oxygen was an enabling factor, just like fertilizer in your garden," explains Jeffrey B. Graham, a marine biologist at the Scripps Institution of Oceanography in La Jolla, Calif. Graham developed the theory along with Nancy M. Aguilar of Scripps, Robert Dudley of the University of Texas at Austin, and Carl Gans of the University of Michigan in Ann Arbor.

Geochemists have long maintained that the proportion of oxygen in the atmosphere has varied on a geologic timescale, but few biologists have considered how such changes would have affected life. In the May 11 NATURE, Graham and his coworkers propose that enhanced oxygen concentrations profoundly altered evolution.

"I've been waiting for some paleontologists to worry about oxygen. Somebody finally has," says geochemist Robert A. Berner of Yale University. Six years ago, Berner suggested the idea of a Carboniferous atmosphere with oxygen concentrations of as much as 35 percent, compared to today's 21 percent.

Oxygen accumulated in the atmosphere then, according to Berner, because much of the dead vegetation sank into the abundant swamps instead of decomposing—a process that pulls oxygen from the air. At the start of the Permian period, about 286 million years ago, oxygen values started falling, eventually dipping to 15 percent.

Berner's model remains uncertain because scientists lack direct evidence about ancient air. But Graham and his coworkers note that if oxygen amounts did indeed increase during the Carboniferous, it may explain why giant dragonflies appeared at that time. Unlike vertebrates, whose circulatory system delivers oxygen to inner cells, insects absorb atmospheric gases through a network of branching tubes that carries air into the body. Interior cells receive oxygen through diffusion, a system that limits the size of invertebrates, the researchers maintain. With more oxygen in the air, invertebrates could have developed bigger bodies.

The additional oxygen would also have helped early flying insects, the scientists suggest. Although the first flyers lacked aerodynamic wings, they would have received extra lift from the denser atmosphere.

Our own ancestors may have benefited as well. During the Carboniferous, four-limbed amphibians clambered out of the swamps and started colonizing the continents. The extra oxygen in the atmosphere may have boosted the efficiency of their primitive lungs, suggest Graham and his colleagues.

With little evidence to support such contentions, the new theory will draw fire from many researchers.

"The fossil record of terrestrial vertebrates does not show convincing correlation with the postulated increase and subsequent decrease in atmospheric oxygen," comments vertebrate paleontologist Robert L. Carroll of McGill University in Montreal.

But Conrad C. Labandeira, who studies insect evolution at the Smithsonian Institution in Washington, D.C., calls the new idea intriguing and worthy of testing through laboratory experiments. Graham and his colleagues hope to examine how insects function in chambers with extra oxygen. —*R. Monastersky*

## No harm in adding a little testosterone

Adding testosterone to estrogen replacement therapy (ERT) can help women combat postmenopausal mood symptoms such as depression and loss of libido. Now, new research indicates that the male hormone, contrary to some fears, doesn't reduce the established cardiovascular benefits of ERT.

Researchers from the Bowman Gray School of Medicine at Wake Forest University in Winston-Salem, N.C., found that postmenopausal macaques treated with estrogen plus testosterone experienced the same degree of protection from heart disease as animals receiving estrogen alone.

Veterinarian Janice D. Wagner reported the results in San Francisco this week at an American College of Obstetricians and Gynecologists meeting. She says the work may significantly "increase the quality of life" of millions of women.

ERT is commonly prescribed to relieve symptoms associated with menopause, such as hot flashes and vaginal dryness. It also helps to prevent osteoporosis and cardiovascular disease.

Despite the benefits, only 10 percent of postmenopausal women use ERT. Wagner says the number one complaint of women getting replacement estrogen is that they "don't feel well." When testosterone is added, Wagner says, women have far fewer complaints.

But estrogen-testosterone formulations are approved only for mood symptoms and hot flashes because of fears that testosterone might undo estrogen's cardiovascular benefits.

The Bowman Gray team tested an estrogen-testosterone formulation in macaques made postmenopausal by removal of their ovaries. The animals provide a good model to test cardiovascular effects of menopause because "they rapidly develop cardiovascular disease after surgery while on a high-fat diet," says veterinarian Michael R. Adams, the group leader.

In his team's study, 12 macaques received estrogen, 12 got estrogen plus testosterone, and 12 served as controls. Monkeys in both treatment groups had one-third to one-sixth the LDL, or "bad" cholesterol, of the control group.

And, when the researchers measured enzymes associated with bone loss, the treated groups had 40 percent less bone loss than controls.

"The addition of testosterone doesn't negate the positive cardiovascular effects of estrogen," Wagner says. And, because women tolerate estrogen-testosterone better, it is likely that more would use replacement therapy. Wagner hopes human trials will follow. — *L. Seachrist*

## Nitrogen: Breaking it up is hard to do

Though humans live in a sea of nitrogen, which makes up 78 percent of Earth's atmosphere, chemists have had a hard time harnessing the inert gas for practical purposes.

Nature takes exquisite advantage of gaseous $N_2$, "fixing" nitrogen by means of biological processes that split the tightly bound molecules before weaving individual nitrogen atoms into compounds. Yet the seemingly simple task of nitrogen fixation continues to stymie chemists seeking easier ways to use the gas in industrial processes.

In the May 12 SCIENCE, chemists Catalina E. Laplaza and Christopher C. Cummins of the Massachusetts Institute of Technology report a novel process for splitting up $N_2$. They use an intermediate molybdenum-containing molecule to cleave the two nitrogen atoms.

Since nitrogen plays such a strong role in organic chemistry, a technique that makes the element more available for chemical synthesis offers great practical opportunities, the chemists observe. Such a method "is clearly desirable if this immense natural resource is to be utilized optimally," they say.

Not surprisingly, the feature that makes nitrogen so stable and inert — a triple bond holding the $N_2$ together — throws up the greatest obstacle to freeing the two atoms to react with other elements. In the new method, the molybdenum-bearing molecule cuts the triple bond and picks up both nitrogen atoms, attaching each to an intermediary chemical complex in readiness for further reactions.

The researchers designed the nitrogen-cleaving molecule with a novel structure that they thought "would display unusual reactivity, and in fact it does."

Conveniently, the reaction takes place in a cool solution of hydrocarbons at ordinary air pressure. "There are no other well-documented reactions that occur the same way, making this manner of $N_2$ cleavage quite interesting," Cummins says.

He believes that the new method's primary contribution may be simply to spark inquiry into other, related methods of cleaving nitrogen molecules.

"The work of Laplaza and Cummins has revealed many interesting prospects, most of which have been only aspirations, or paper chemistry, until present," says G.J. Leigh, a chemist at England's University of Sussex.

Having long tried to mimic nature's methods of nitrogen fixation, Leigh adds, chemists may now see in the work of Laplaza and Cummins a chemical reaction "that is radically different." —*R. Lipkin*

# Quark matters: Birth of a strange dwarf

A white dwarf is a dead, collapsed star. Nuclear fusion reactions no longer fuel its glow. Electrons and atomic nuclei in its crust and core lie so tightly packed that all atomic structure is lost.

Researchers now propose that a fraction of these diminutive stellar corpses may harbor cores that include strange quarks as one of their constituents. The presence of such quark cores would stabilize these stars, allowing them to exist over a wider range of masses and core densities than possible for white dwarfs composed of just ordinary matter.

Normally, a white dwarf packs the equivalent of the sun's mass into a ball roughly the size of a modest planet, while neutron stars — the crushed relics of supernova explosions of giant stars — can have similar masses but diameters of 40 kilometers or less. "The strange dwarf fills the gap between ordinary white dwarfs and neutron stars," says Norman K. Glendenning of the Lawrence Berkeley (Calif.) Laboratory.

Glendenning and his collaborators describe this "possible new class of very dense white dwarfs" in the May 1 PHYSICAL REVIEW LETTERS.

The existence of compact stars containing strange matter hinges on the hypothesis that a quark nugget consisting of roughly equal proportions of up, down, and strange quarks may be more stable than an ordinary atomic nucleus, which contains only up and down quarks (SN: 3/4/89, p.138). Researchers have looked for strange matter in accelerator experiments and elsewhere but so far have come up with no unequivocal evidence either confirming or rejecting the hypothesis.

A strange dwarf consists of a tiny quark core surrounded by a hefty overlay of nuclear material, up to a few thousand kilometers thick. A thin layer of electrons surrounding the positively charged quark core keeps it out of direct contact with the crust of ordinary matter lying above it.

The nuclear material in the deep interiors of such stars can have a density up to 40,000 times higher than that found in typical white dwarfs, the researchers say.

Where could a strange dwarf's quark core come from? Glendenning and his colleagues speculate that if quark nuggets exist in the galaxy, they would readily contaminate any objects with which they come in contact. Over billions of years, enough of this material could accumulate in a main-sequence star to leave a core of strange matter when the star dies. —*I. Peterson*

# Map unfolds for brain's vision areas

Thanks to advances in brain-imaging technology, scientists have taken the first step toward delineating the location and characteristics of a cluster of interrelated patches of brain tissue that orchestrate vision.

Until now, knowledge about these regions came almost entirely from monkey experiments that relied on invasive methods such as electrical stimulation of the living brain.

"We're at the threshold of understanding much more about the human visual cortex and its possible role in higher mental functions, such as language comprehension," asserts Martin I. Sereno, a neuroscientist at the University of California, San Diego.

Sereno and his colleagues used functional magnetic resonance imaging (MRI) to study the brains of seven volunteers, they report in the May 12 SCIENCE. Functional MRI creates images of brain anatomy and determines localized activity from measurable responses of the brain to a strong external magnetic field.

MRI images taken while volunteers viewed a slowly rotating semicircle revealed activity in the cortex, the brain's outer layer, that changed according to the angle of gaze registered by the retina. Images taken while viewing a thick ring that slowly expanded or contracted yielded information on cortical areas sensitive to the point in the visual field at which a participant's gaze was directed.

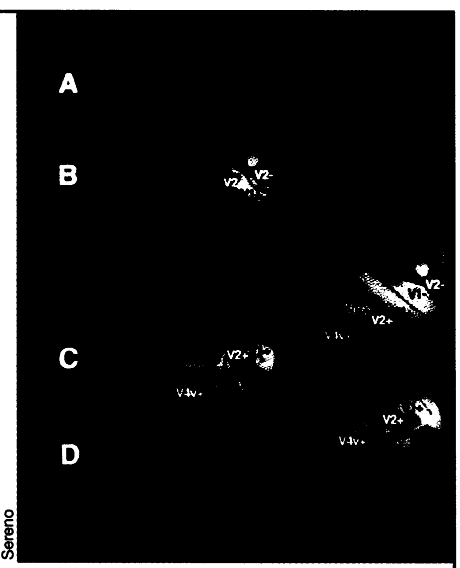
A computer program transformed MRI scans of each participant's brain from a bunched cortical surface to a flat expanse of tissue. Data from the two visual trials were then fitted into these flattened images, which allowed researchers to isolate all activated parts of the cortex.

The researchers mapped out five adjacent segments of the visual cortex by noting magnetic signal changes from one region to the next. The location of only one of those areas, the primary visual cortex, or V1, had already been traced in humans, Sereno says.

Humans and monkeys display a number of similarities in the shape and organization of these visual areas, he notes. However, mapped areas of the human visual cortex place far more emphasis on processing information from the center of gaze than do corresponding areas of the monkey cortex.

For some reason, the human visual cortex evolved a preference for extracting information from the center of the visual field when assembling elements of a scene, Sereno proposes.

Further MRI work may uncover links




*Blue and yellow patches designate mapped areas of the human visual cortex viewed from the side of a folded (A) and an unfolded (B) brain surface and from the bottom of a folded (C) and an unfolded (D) surface.*

between the visual cortex and some types of linguistic ability, he adds. Part of the visual cortex not mapped in the current study lies just below Wernicke's area, a structure involved in speech and language comprehension, according to Sereno. —*B. Bower*