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THIS WEEK

RESEARCH NOTES

ARTICLES

COVER: Black-tailed prairie dogs keep watch at the entrance to their burrow near Denver, Colo. Scientists are intrigued with the organized social structure of the prairie dog society. But the protection provided by the community warning system cannot defend against the encroachment of human society. See p. 29. (Photograph courtesy of U.S. Department of Interior, Fish and Wildlife Service)

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SCIENCE NEWS OF THE WEEK

Evolution at the AAAS

Weather outside was frightful, but inside it was science as usual. The site was a frigid Toronto. The occasion was the 147th annual meeting of the American Association for the Advancement of Science. And this year, in addition to the expected smorgasbord of science, the meeting had a special emphasis — directing science toward peace. For three days attendees were told of the dangers of nuclear proliferation, the necessity of getting serious arms control negotiations underway, the inadvisability of building the MX missile system and the impracticality of particle beam weapons.

Another topic that provided heat, if not light, was the revived anti-evolution movement. Physicist Rolf M. Sinclair of the National Science Foundation organized a session titled "Views of the Universe: Science versus Tradition." He came out of his ivory tower, he says, and was shocked to find out what the creationists are doing in schools. Their success in getting school districts to teach creationist ideas is restricting and perverting science education, he says.

The anti-evolution movement, explains William G. Mayer, director of the Biological Sciences Curriculum Study in Boulder, Colo., is a well-funded single-interest group "whose pervasive monomania bodes ill for education. Its attempts to influence state legislatures to mandate its beliefs occupy time and consume taxpayers' money. Anti-evolution efforts have diverted resources in states as diverse as Illinois, Iowa, Texas, Mississippi, Georgia and Indiana." The anti-evolutionists have been successful, he explains, because they now use a Madison Avenue approach and employ full-time staff while "there is not one scientist who is funded to devote full time to espousing evolutionary theory."

Not only are the creationists well funded, they know how to use science itself to fight against evolution. Big bang cosmology, for instance, is cited as evidence for the concept of divine creation. Milton K. Munitz of the City University of New York addressed this question and explained the difference between the physicist's concept and the fundamentalist's concept of the beginning of the universe. "Any interpretation of the notion of an absolute beginning of the universe as consisting in an alleged event impervious to further scientific investigations," he said, "simply misreads the logic of the situation." It's a philosophical or logical mistake, he says, "to look to those evolutionary scientific cosmologies that involve the concept of a beginning of the universe as support for a sophisticated traditional theological doctrine of creation."

Discussing the evidence for evolution, Smithsonian Institution scientist Porter M. Kier, former director of the National Museum of Natural History, said there are 100 million facts that support evolution. "In the museums of the world," he says, "there are over 100 million fossils that have been identified and age-dated. These fossils have been examined by many thousands of paleontologists and from their investigations we have learned a vast amount about the history of life on earth." Despite this evidence, Kier admits, "there are many well-educated people still questioning evolution. Part of the problem may be that evolution has been described as the 'theory' of evolution, which gives an erroneous impression — that scientists themselves don't accept evolution as accepted." The word "theory," he says, has done a great deal of damage and should be dropped and the word evolution should stand alone. "Scientists may argue over the details of evolution," he says, "but they agree that evolution is a fact and should be so labeled."

Why is it necessary to say all of this to a room full of scientists? Because the scientific community does not recognize the extent of the problem and has been apathetic in approaching it. Mayer says, "There has been little interest within the scientific community in anti-evolution arguments, which most scientists dismiss as nonsense on a par with the concerns of the flat earth society." But because anti-evolutionism can have damaging effects on science education, it is time for scientists to speak out. The session at this year's meeting, explains Sinclair, is just a beginning. The theme of next year's AAAS will be Science Education, and tentatively it will include discussions of ways to combat creationism and the teaching of religion as science. □

Jaws repellant and other sea treasures

Like a lion tamer's head in the king of beasts' mouth, the Red Sea Moses Sole hovers safely between the jaws of a reef white-tipped shark. Although the shark has just completed the "hunting turn" that characteristically precedes a shark attack and now has the Red Sea flatfish within its gape, it quickly veers away without harming the sole. At the American Association for the Advancement of Science meeting last week in Toronto, researchers explained that a milky secretion from the Red Sea flatfish is responsible for this marine phenomenon.

University of Maryland's Eugenie Clark

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discovered that sole secretion two decades ago. While early studies revealed the secretion's toxicity to certain fish, it was not until the 1970s that scientists began to focus on the shark-repelling property of the substance, which is stored in ampule-like glands located along the dorsal and anal fins of the Red Sea flatfish. Now, Naftali Primor of New York University Medical Center and colleagues have isolated the toxic component, called pardaxin, and have begun to detail its mode of action.

Pardaxin is an acidic protein composed of a single chain of 162 amino acids with four disulfide bridges — bonds between the sulfur groups on the amino acid chain. In studies using dogfish sharks, Primor and co-workers discovered that pardaxin affects the permeability of the gills, resulting in a greater movement of ions between the shark's blood and seawater. In related studies, Primor's group observed pardaxin-induced shark behavior. When sharks are exposed to pardaxin, they first exhibit an "escape response," immediately turning away from the source of the toxin. Primor and co-workers also observed secondary responses, from rapid opercular (gill-covering) movements to loss of equilibrium — the shark sometimes turns upside down or on its side.

Whether the shark's split-second escape and various secondary responses to pardaxin are related to that chemical's effect on its gills is just one of several mysteries researchers must solve before an effective shark repellant can be developed. "It's a long step between knowing that something seems to act as a kind of repellant and having an effective shark repellant that can be used practically," Bernard J. Zahuranec reported at an AAAS symposium on the topic. "Even if you know some material acts as a repellant, like the Moses Sole milky secretion, you can't use that by going out and harvesting Moses soles and milking their material and bottling it," said Zahuranec of the Mississippi detachment of the Office of Naval Research. Instead, he explained, researchers must pin down the material's precise mode of action so that chemists can mimic it with a cheaper, more convenient synthetic compound.

Then, "Shark repellant research ... can serve as a useful paradigm for research on other biologically active substances from the sea," Zahuranec said. Researchers could isolate, for example, a chemical compound certain sea creatures use to repell the shipworm, a clam that causes millions of dollars worth of damage each year by boring into the underwater portions of piers and waterfront warehouses. Another marine compound of interest is the biological adhesive that masking crabs secrete to glue camouflaging shells to their backs. This "wet environment" glue could be useful in dentistry, says William O. McClure, director of the Marine Bioactive Substances Program at the University of Southern California.

Jeff Albertson/NOVA

McClure's researchers — who recently isolated a group of anti-viral compounds, dubbed didemnids, from marine tunicates —focus on the pharmaceutical band of the wide-ranging marine chemical spectrum. While the interest in marine pharmaceuticals dates back to the ancient Sumerian medications made from the pulverized skins of venomous water snakes, the field is only now maturing, says McClure, because it previously lacked chemists to isolate the relevant compounds, determine their structures and synthesize chemical copies of "tomorrow's drugs from the sea." Such drugs, says McClure, may "provide entirely new medications and alternatives to existing ones that may be overexpensive because of scarcity or undereffective because of bacterial resistance." □

High-powered electron microscopy

Looking directly at biological specimens is one experimental approach that can provide increasingly sophisticated answers to scientific questions. Electron microscopy now extends vision down to the level of individual atoms (SN: 10/21/78, p. 277). F. Peter Ottensmeyer and D. P. Bazett-Jones of the Ontario Cancer Institute in Toronto are focusing the electron beam on biological materials. With modifications of standard electron microscopy, they directly observe the structure of proteins, and with the addition of filters, they map, on a nanometer scale, the elemental composition of cellular components.

Electron microscopy of small biological molecules has been limited by the necessity of coating specimens with heavy atoms to make them visible against the background carbon film. "The stain is needed for contrast, but it robs us of resolution," Ottensmeyer says.

Ottensmeyer circumvents the staining procedure by three modifications of microscopy procedure. He employs a trick of light microscopists to double resolution by arranging lenses, slits and focus so that the specimen is viewed against a dark, rather than a bright, field. He supports the specimen on an extremely thin (20 angstrom) carbon film, to reduce the contribution of that material, and he compensates for the film's random background noise by using computer techniques to average the images of different copies of a molecule. With these methods, for example, he can clearly demonstrate the shape of a benzene ring.

A low level of electron bombardment is another key to success, Ottensmeyer says. Other scientists have argued that radiation damage would destroy biological specimens before useful data could be collected. Ottensmeyer minimizes the radiation dose by recording as the first electrons hit the sample. "The camera opens on a virgin molecule," he says. "It dies as we look at it."

Among the molecules Ottensmeyer has visualized as they crumple under the electron beam are the hormones vasopressin, glucagon and ACTH. The shape of some enzymes, such as myokinase, which is 50 angstroms in diameter, also has been determined at a resolution of 5 to 10 angstroms. The configuration agrees well with that determined by X-ray crystallography.

In other cases, the microscopists propose a structure based on shape and biochemical data, then must wait for crystallography to confirm it. For example, from the many-fingered shape of protamine, an enzyme that wraps up DNA in sperm, they have been able to propose a detailed three-dimensional structural model. "We now frequently observe the fine structure of proteins with remarkable detail, which can be meaningfully interpreted on a near-atomic biochemical level," Ottensmeyer says.

Teasing further information from electron microscopy is possible by filtering electrons on the basis of their energy. Electrons lose energy by exciting atoms and molecules as they pass through the specimen; the amount of energy an electron loses depends on what atom or molecule it has excited. Ottensmeyer built a device that spreads the electrons into a spectrum like a prism and produces an image with the electrons of a selected energy range. This addition to the microscope "permits the direct selective visualization of the location of specific kinds of atoms in the specimen," says Ottensmeyer. "In one fell swoop, we've analyzed the entire image."

Growing bone is one biological system the microscopists have been examining. They make an image of the region where mineralization is underway. By comparing the images derived from electrons in the energy ranges indicative of calcium, phosphorus and sulfur, they find that a matrix of phosphorus and sulfur is laid down before precipitation of calcium occurs.

The configuration of genetic materials complexed with proteins in bead-like structures called nucleosomes also is amenable to electron microscopic analysis. "With our microscope we can look inside a single bead," Ottensmeyer says. Because DNA has much more phosphorus than does protein, he examines the images made by the electrons indicative of phosphorus. Most of the images can be inter-