In a paper recently submitted to SCIENCE, the Crowes describe how sugars can prevent dry pollen grains from leaking their contents when they are rehydrated, a major cause of pollen and seed death. "We've been able to show that leakage is a membrane phenomenon involving a phase change [between gel and liquid crystalline states] in the membrane phospholipids," says John Crowe. Since the phase of the membrane is temperature-dependent, a dried grain in the gel phase can be converted to the liquid crystalline phase by heating. When the dried, heated grain is then placed in water, it stays in the liquid crystalline phase and survives. The sugars make this possible by reducing the temperature at which the pollen grains transform from the gel phase to liquid crystalline; with sugars, this transition temperature is about 30°C, but without sugars, the pollen grain must be heated to 60°C, a temperature that would destroy the grain.

Besides enhancing seed and pollen survival, the sugars' ability to tightly control the phases of many other kinds of molecular assemblies will give scientists a powerful tool for dictating other properties — such as sensitivity to light or whether or not a material polymerizes — of a wide range of biomaterials, Alan Rudolph believes. "The things we're now learning about the interactions between sugars and other molecules could in 20 years have an important impact on all these areas that involve the preservation of biological structures," he says.

While the Crowes and their contemporaries have made the most progress in extracting and using the dehydration secrets of anhydrobiotic creatures, they are not the first scientists to be fascinated with the phenomenon, which challenges the very notion of what it means to be alive. In 1702, the pioneering microscopist Anton van Leeuwenhoek first alerted biologists to the seemingly death-defying feats of tiny "animalcules" he had found in rooftop sediments. Writing to the Royal Society of London, he noted that the creatures became immobile and contracted into oval shapes upon drying, but that within half an hour of stirring the dried animals in a glass of water, he saw them swimming about.

For some years, many biologists believed that Leeuwenhoek's animals, and other animals that subsequently were shown to survive dehydration, actually died when they were dried and that they could be rescued from the clutches of death by water in a process that was then dubbed "anabiosis," or return to life. The existence of such animals became part of the arsenal of evidence used by some scientists in the 19th century to garner support for the doctrine of spontaneous generation, a now-defunct theory holding that life originates from lifeless matter.

Most modern scientists do not believe that dried animals revived by water have ever been dead. After all, some dehydrated animals, for a variety of reasons, may never spring back to life after moistening. "Does this mean they died while being dead?" asks John Crowe. In order to purge the anabiotic process of its spontaneous-generation taint, he says, scientists in this century renamed it cryptobiosis, meaning return to life, or anhydrobiosis, meaning life without water.

Still, he notes, scientists studying anhydrobiosis continue to grapple with the question of life or death. This is largely because one traditional measure of life has been metabolism — for example, do the anhydrobiotic animals consume oxygen and process other gases in their dried state? After numerous studies, says John Crowe, "the issue is still not fully resolved, although the weight of evidence says that [metabolism of dried animals] does indeed stop completely. So you get into a logical quandary if you define life in terms of metabolism."

What, then, is life? After probing around at the molecular level and seeing how sugars can act as structural understudies for water, John Crowe prefers instead to "define life as organized structure. As long as the structural integrity of the organism is intact, it's alive. When the structure is violated, it's dead." □

Books

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Annual Review of Cell Biology, Vol. 3 — George E. Palade, Ed. Concentrates on topics central to cellular and molecular biology. Annual Reviews, 1987, 502 p., charts & graphs, $31.

Dinosaurs Past and Present, Vol. 2 — Sylvia J. Czerkas and Everett C. Olson, Eds. This lavishly illustrated volume concludes the investigations undertaken by a panel of scientists and artists at a symposium held at the Natural History Museum of Los Angeles County (see: SN: 10/4/86, p.216). The contributors here provide examples of how physical evidence can be interpreted, correctly or incorrectly, in the restoration of extinct animals. The final paper sheds additional light on the demise of the dinosaurs. U of Wash Pr, 1988, 149 p., color/b&w illus., $35.

Frogs & Toads of the World — Chris Mattison. A comprehensive overview of these fascinating and diverse creatures. They range from the largest known frog, the Goliath from West Africa, which can exceed 12 inches in length, to a frog found in Brazil that is 9.8 mm or 0.386 inch. Well illustrated, this book discusses the 21 families of frogs and toads, their life histories with their metamorphosis from tadpoles to frogs, their physiology, reproduction, food and feeding enemies and defense, distribution and movement. Facts on File, 1987, 191 p., color/b&w illus., $22.95.

Plants Plus — George Seddon and Andrew Bicknell. Explains in detail various forms of plant propagation for the indoor and outdoor gardener. Illustrates and describes annuals, herbaceous perennials, shrubs, bulbs, vegetables, herbs, soft fruit, bromeliads, cacti and succulents, ferns and orchids and gives the preferred method for propagation for each different plant. Rodale Pr, 1987, 160 p., color illus., paper, $14.95.

Portraits of Earth — Freeman Patterson. "Just as we study a face in order to know a person," says the author, "so we examine an earthscape . . . in order to understand Earth itself." The magnificent photographs of breathtaking beauty express Patterson's deep love of the natural world. In the text he takes the readers behind the lens of the camera to show earth through his eyes and to help the readers sense its shapes, its lines and its textures. Sierra, 1987, 180 p., color illus., $35.

The Secret House: 24 Hours in the Strange and Unexpected World in Which We Spend Our Nights and Days — David Bodanis. An account of the astonishing physical and biological events that take place in a house during our sleeping and waking hours. Much of what is described is invisible to the naked eye or inaudible to the human ear. Reveals how processed foods are made, how polyester shirt fibers create an electrostatic field that guarantees dirty collars and cuffs, why potato chips snap, why pantyhose rip and a host of other interesting facts. Illustrated with electron micrographs, thermographs and computer-enhanced X-rays that give a unique view of the world around us. Originally published in hardback in 1986. S&S, 1988, 224 p., color/b&w illus., paper, $9.95.

The Tanagers: Natural History, Distribution, and Identification — Morton L. Isler and Phyllis R. Isler. With the exception of four species that breed in the United States, most tanagers dwell in the dense and often remote forests of Central and South America. In preparing this book, the authors observed tanagers in the field, compiled information from more than 1,000 references, studied museum specimens and gathered unpublished behavioral data from many contemporary ornithologists. A map accompanies each species account, and the 32 color plates illustrate 551 plumages and 23 flight patterns. The purpose of the book is to encourage field study and conservation of tanagers and their habitats. Smithsonian, 1987, 404 p., color/b&w illus., $70, paper, $49.95.