RESEARCH NOTES

Some recent developments in the fields of biology, applied science, and engineering that help explain more about man and his environment

Exchanging Hormones

Three Caltech biologists have discovered that a tree common in southern California converts cholesterol into a hormone that triggers metamorphosis (molting) in insects—transforming caterpillars, for example, into butterflies.

Erich Heftmann, research associate in biology, and research fellows Raymond D. Bennett and Horst H. Sauer have found that this hormone, ecdysterone, is synthesized from cholesterol by the *Podocarpus elata*, an Australian evergreen used in landscaping. Many other plants probably also manufacture the hormone.

Most insects cannot synthesize cholesterol or other sterols although they may be able to convert them to ecdysterone or other molting hormones. It is still not clear whether insects obtain the hormones directly from the plants by eating leaves or whether they convert the plant sterols to hormones themselves.

The Caltech men made their discovery by applying cholesterol tagged with radioactive carbon-14 to the leaves of Podocarpus seedlings. After a month's time, tests showed that the Podocarpus contained ecdysterone carrying the radioactive carbon-14 atom--proof that the plants had converted the administered cholesterol into the molting hormone.

Biologists thought earlier that only animals synthesized cholesterol, which is the basic material from which they make other steroids including certain hormones. However, Heftmann and his Caltech associates have shown that higher plants also synthesize cholesterol and that some contain the same sex hormones as those produced by animals.

The Heftmann group is continuing research to determine if any of these animal hormones also perform functions in the lives of plants. Their work is supported by the Agricultural Research Service of the U.S. Department of Agriculture.

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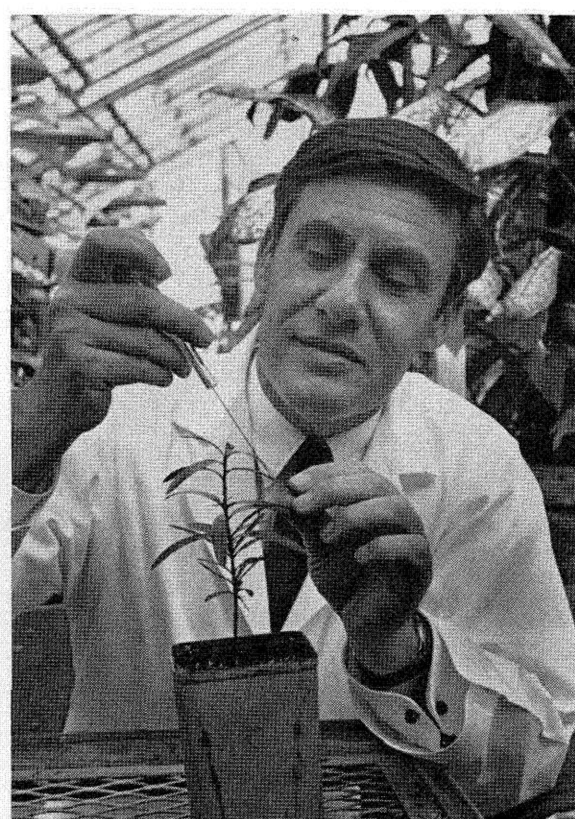


Erich Heftmann, research associate in biology.

Do human beings see in the same way that cats and monkeys do?

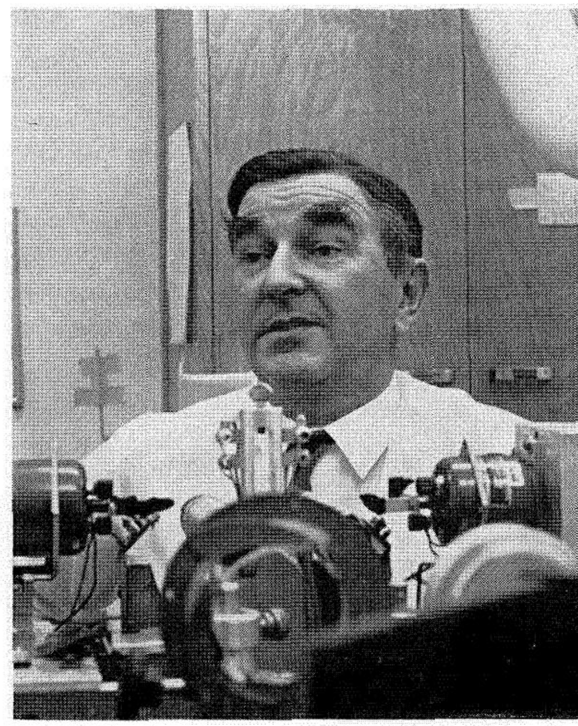
Derek H. Fender, professor of biology and applied science at Caltech, is looking for answers to questions like this in his current studies on how the human brain processes visual signals. Working with him is Dietrich Lehmann, neuropsychiatrist of the Institute of Visual Sciences in San Francisco.

The small part of each hemisphere of the brain that is involved in seeing contains several varieties of specialized neural cells. Tests on cats and monkeys have shown that some of these neurons measure light intensity, some analyze straight lines, others observe dots, and still others, binocular disparity. The current research of Dr. Fender and Dr. Lehmann is one of the first demonstrations that neurons with similar functions exist in human beings.

Twenty-seven women subjects are serving in these experiments which test their reactions to various images flashed on a screen in a dark room. The very small electric signals generated by the optic centers of their brains are recorded by means of electrodes attached to the backs of their heads. Normally, such tiny signals are lost in the general electrical activity of the brain, but in this case computer processing erases the background "noise" and permits the researchers to retrieve only the light-evoked signal. They call this response light-evoked potential (LEP).

The two scientists are trying to get more information about the brain cells that give rise to the LEP. Where are such cells located? Are they classes of cells that respond to specific abstractions of the visual field? How do these classes interact with each other in the complicated process of everyday visual experience?

To do this kind of research in the past, a flashing light was used to project a picture into one or both eyes. Dr. Fender and Dr. Lehmann rejected this method, however, because they felt that the flashing light and the structure of the picture could interact in the retina and thus tell very little about the brain. Instead, the Caltech system is to stimulate each eye simultaneously with a different target. One eye always sees a flash, for example, while the other sees a structured or textured target illuminated by a steady light source. As a result, the flash and the structure can only interact in cells in the brain.



Derek Fender, professor of biology and applied science, studies the mechanics of seeing.

This work has shown that the size of the LEP decreases as the amount of structure increases—a fact which researchers interpret in this way: In monkeys and lower animals it has been shown that there are classes of cells in the brain that respond to elemental processes in the visual field—straight lines, for instance. If a subject views a blank field, none of these cells will be active, and they can be shocked into synchronous activity by a bright flash. But if one eye sees a straight-line grid pattern, some of the straight-line detectors will be "busy" so that fewer of them can be activated into synchronous activity by a flash—and so the LEP is smaller.

LEP's are modified by other mental activity such as involvement with and interest in the experiment, motivation, boredom, vigilance. It is essential that these badly defined and not very well understood attributes of human mental activity remain constant through the experiment—about two hours.

It is interesting to note, then, that women have proved to be exceptionally good subjects for these experiments. Men are hopeless.

Can Fungi Help Purify Water?

More efficient methods for converting waste water into drinking water may result from a Caltech study of the fungi found in the soil.

James V. Harvey, a project scientist conducting research in the environmental health engineering laboratory, has isolated numerous species of fungi found in waste-water spreading grounds and is now trying to determine what role they play in purifying water.

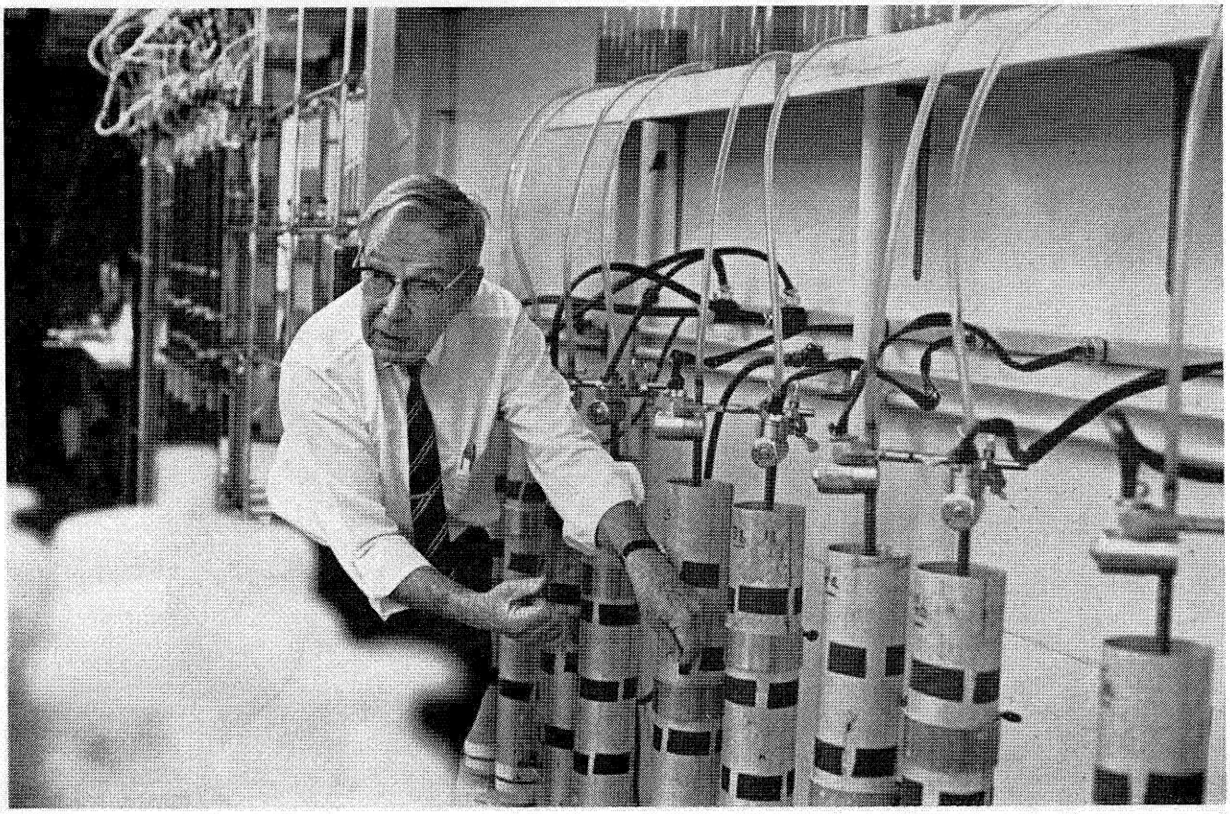
Dr. Harvey is examining the composition and significance of various species of fungi found in a soil area that is being treated daily with two feet of highly oxidized effluent. This effluent, treated sewage, is from the Whittier Narrows area near Los Angeles.

Dr. Harvey, a mycologist involved for years in the study of destructive molds, is conducting the study under Jack McKee, professor of environmental health engineering. His research is supported by the Federal Water Pollution Control Administration.

More than 50 species of fungi have been isolated during the study. Now, Dr. Harvey's goal is to find out what substances are being attacked by the fungi and to determine if fungi act in the same manner as bacteria.

It has long been known that bacteria play a major role in the purification of water as it seeps down from the soil surface. Dr. Harvey hopes to determine if there are any cooperative relationships between bacteria and fungi during water purification. He has constructed a system of 16 aluminum tubes filled with sterilized sand through which measured quantities of sewage water (secondary effluent) from the spreading grounds are dispensed at scheduled intervals. After about six weeks of "ripening," the soils are presently undergoing analysis to determine what fungi are present and which ones are degrading certain substances in the water.

Since the fungi cannot manufacture their own food as do green plants, they are dependent upon existing organic matter. Thus, if fungi survive in the sewage-treated soil, they may have to live on carbon compounds in the effluent and may also make use of nonorganic compounds in the water.



In water purification experiments conducted by James Harvey, sewage dumped into a complex system of aluminum tubes filters through sterilized sand and is then tested for fungi and bacteria.