EROS scientists claim that this passage, and the entire section, is unfair, since ERTS was never intended to be used in the production of standard maps, and since the uses of low-resolution sensing are completely different from those of high-resolution photography. ERTS backers fear that the Donelson group aims to substitute classified low-resolution programs for ERTS, thus nullifying the need for future, unclassified programs. At the very least, they fear, ERTS or its successors will be at the bottom of the totem pole in the new agency, and they cite the report's caustic comments as evidence.

At present, there is no way of knowing whether the upper levels of government are aware of the disputes which the Donelson report has stirred in the mapping community. In fact, the entire mapping controversy would appear to be a problem in search of a science adviser. An NSF spokesman says that someone in the new science and technology policy office is reviewing the report "on behalf of" H. Guyford Stever, the NSF director who is the President's science adviser. But whether Stever's voice will be heard in the interagency wrangling of the next few months remains to be seen.

—DEBORAH SHAPLEY

Addiction Research Center: Pioneers Still on the Frontier

Ever since the middle 1930's, the Addiction Research Center (ARC) near Lexington, Kentucky, has been, in effect, a national laboratory for research on narcotics. Because it is the only place where narcotics research using human subjects—volunteers from the federal prison system—has been permitted, the ARC has been literally the center of research in the pharmacology, physiology, and neurology of addiction. And government scientists there have produced the major body of work on the subject.

The Lexington center was established as the principal research arm of the Public Health Service (PHS) in the narcotics field. For many years the center operated as a division of the federal narcotics hospital at Lexington, which is scheduled to be taken over by the Bureau of Prisons early next year (*Science*, 7 December). The ARC, which has been administered within PHS by the National Institute of Mental Health since 1947, will continue to operate in a wing of the hospital but will retain its affiliation to NIMH after the Bureau of Prisons takes over the hospital.

The contributions of the Lexington researchers have ranged across applied and basic research. Standard withdrawal techniques for morphine and heroin and later for methadone, barbiturates, and alcohol were developed there. The scientific characterization of the morphine abstinence syndrome and tests for opiate dependence came out of the center. Over the years, a mass of information on the addictive effects of new drugs has been produced by the ARC. In recent years pioneering studies on the narcotic antagonists and research on long-term physiological changes caused by opiate use has been among the most important work done there.

The researchers at the ARC have belonged to the PHS Commissioned Corps or held Civil Service status. Probably because the ARC unit has remained small, administrators at the center have kept active as researchers. Among those who were influential in the center's early and middle periods were Lawrence Kolb, first director of the hospital; Clifton K. Himmelsbach, first head of the research division which became the ARC; and Harris Isbell, director of the center from 1944 to 1963. The current director, who guided ARC during the process of separation from the hospital, is William R. Martin. All have been names to conjure with in addiction research.

It was Himmelsbach, an M.D.–pharmacologist who had been groomed for the job as first head of the research division, who first put together a multidisciplinary mix of physicians, psychiatrists, psychologists, physiologists, and chemists. One close observer says it may have been the first clinical research team in the present sense.

At the beginning, says Himmelsbach, the center was assigned two main purposes. The first was to search for a nonaddicting analgesic—"the bee without a sting." The second purpose was to study the actions of narcotics and to develop a rational approach to treatment. The magnitude of the task facing the center is not easily appreciated today, for 40 years ago very little was known about narcotics and less about addiction.

When the Lexington hospital was opened in 1935 there was no effective technique for the withdrawal of addicts from morphine. "And some of the methods used were worse than nothing," says Himmelsbach. "We had to find a way to separate a man from the drug in a respectable way." It must be recalled that in those days, before the criminally organized international traffic in heroin, addicts had access to relatively pure narcotics, and withdrawal was a more harrowing and dangerous process than it usually is today. Lexington researchers developed the process of gradual withdrawal from opiates, which was standard until methadone came along to make it easier.

A basic understanding of addiction was lacking in the early days. Himmelsbach recalls, for example, that "a lot of people thought [the withdrawal syndrome] was in the mind." Himmelsbach's research helped to establish a detailed knowledge of physical dependence, and he was also instrumental in developing tests for dependence.

A major theme at the center continued to be the search for a nonaddicting narcotic, even though the goal seemed to keep receding. To understand the rationale behind narcotics research in this period, it is necessary to recognize the high priority given the effort to find a nonaddicting narcotic. In some ways, it took on the quality of a quest for a grail; certainly it heavily influenced the shape of the research program into the 1950's.

It is not surprising that addiction research in those days was a small, closed world. Such research was un-

fashionable scientifically, at least in part because society viewed addicts as outcasts and because stringent drug laws discouraged researchers from working with narcotics, particularly with addicts.

Under the circumstances, it might be expected that research would be tightly controlled and dominated by strong personalities. Such certainly was the case. A pivotal figure in narcotics research in this period was Nathan B. Eddy, a physician with research credentials. Eddy's significant involvement with narcotics research began when the National Research Council (NRC), at the end of the 1920's, formed a Committee on Drug Addiction to continue research on narcotics which had been supported by the Rockefeller-sponsored Bureau of Social Hygiene in New York City. Eddy was selected to take the lead in the effort to find a nonaddicting analgesic, and he was to be identified with that line of research for the rest of his long career.

Eddy played a primary role in the NRC committee as it went through several name changes and broadened its concerns and its influence. In the post–World War II period, Eddy was associated with the committee as a member and was twice chairman; from 1961 to 1967 he was executive secretary; he was consultant at the time of his death in 1971.

During practically the entire period Eddy remained active as a researcher, first at the University of Michigan and later at the National Institute of Arthritis and Metabolic Diseases. Strategically placed, dedicated to addiction research, and with firm views on research priorities, Eddy acquired a considerable degree of influence over both research funds and the flow of narcotics to investigators. A triangular network developed comprised of Eddy and the NRC committee, the ARC, and selected researchers at universities, particularly the University of Michigan. The key man at Michigan was Maurice H. Seevers, the strong-minded chairman of the medical school's Department of Pharmacology, who, among other things, established at Michigan a monkey colony which figured in a series of important studies involving narcotics and hallucinogens.

Particularly in the late 1940's and the 1950's as a flood of new drugs became available, Eddy acted as a kind of Washington connection, with sufficient personal authority to influence where research money and drugs for experimental drugs would be directed. The university researchers came up with new ideas and did animal studies. Lexington, in addition to its own program of basic research, did all the studies of the effects of pain-killing drugs on humans. Because of a virtual monopoly on expertise, Eddy, Seevers, Isbell, and their colleagues were relied on by the government for advice on drugs of abuse and actually became a part of the machinery for making policy on narcotics on both the domestic and international scenes.

Before he died in 1971, Eddy had worked hard to complete a book which documents NRC activity from the establishment of the Committee on Drug Addiction to 1971. That book, published recently*, traces in detail the changes in organization and policies which occurred over the years, identifies key individuals, and provides an extensive bibliography of the research done in the period. The book does not, however, convey much about the atmosphere or the special ground rules that must have prevailed in this perhaps unique, extraordinarily self-contained research effort.

Fading Hopes

One of the ironies of the period is that Himmelsbach and his successors consistently came up with results that crimped hopes for a nonaddicting analgesic. Finding a strong painkiller which is, at the same time, nonaddicting seemed to involve a scientific contradiction. Isbell, who carried out studies on a number of synthetic narcotics after the war, recalls that researchers began to conclude that analgesic effects and addictive effects are directly linked. "The analgesics forced you into it," says Isbell. The molecular structures of the drugs all had a "chemical twist" that made them look and act like morphine.

It was immediately after World War II that hopes for a nonaddictive analgesic rose highest, with the advent of a number of new synthetic drugs. A scientific team had brought back samples of synthetic narcotics developed in Nazi Germany. Methadone, one of these drugs, was briefly seized on as a possible answer to the problem but soon proved simply to have a pattern of effect different from that of morphine. The use of methadone to detoxify opiate addicts was developed at the center.

It is interesting and probably significant that methadone maintenance programs were not developed there. Replacement of one addicting drug by another, even if the second has no "agonistic" effects and prevents euphoria from the use of other opiates, went against the grain of the official policy and of the people in the NRC-ARC-university system.

In the years directly after the war the primary research emphasis at Lexington changed from seeking a nonaddicting analgesic to preventing the marketing of morphine-like drugs without adequate controls. One drug after another was sent to Lexington for testing, and Isbell and others recall that it put heavy demands on the center. In the early 1950's, however, Isbell turned his attention seriously to the study of narcotic antagonists, drugs which block the effects of morphine and other opiates by preventing them from affecting the nervous system (*Science*, 6 August 1971 and 21 July 1972). This work on antagonists has continued and forms part of an effort to combine several lines of research in a comprehensive strategy for effective treatment of addicts.

Narcotics addiction involves psychological dependence as well as physical dependence, and from the early years the ARC's multidisciplinary staff has studied the role of conditioning in the abstinence syndrome. Abraham Wikler, a psychiatrist-neurologist now at the University of Kentucky medical school, is primarily identified with the work at Lexington which established that an addict's drug-seeking behavior after withdrawal is at least partly conditioned. Persons who become physically addicted under street conditions also undergo environmental conditioning. The withdrawal process does not erase this conditioning, and such people experience drug craving instantly when they return to the street, says Wikler.

What are the implications for treatment and rehabilitation of addicts? How is it possible to extinguish a conditioned response rather than to stimulate it by returning an addict to the community? Wikler suggests that a practicable extrication plan requires that an addict be treated with antagonists for at least a year and that the process involve the self-injection of heroin by the addict under street conditions. Only with such use, with the heroin effects blocked, is there a real chance of extinguishing the con-

* *The National Research Council Involvement in the Opiate Problem, 1928–1971*, available from the publications office, National Academy of Sciences, 2101 Constitution Avenue, NW, Washington, D.C. 20418. $10.

ditioning, says Wikler. He notes that it is virtually impossible today to find such a regimen in existing narcotics rehabilitation programs.

The heavy odds that an addict will relapse has made some scientists postulate that there are long-term, perhaps even permanent, physiological changes that may contribute to recidivism. Observations by Himmelsbach and others suggested that effects of addiction persisted beyond the initial withdrawal period, and Martin and his colleagues have found evidence of what they call a "protracted abstinence syndrome." With opiates and synthetic opiates the abstinence syndrome appears to have two phases. The familiar, overt physical withdrawal signs are gone in perhaps a month. There are a number of signs that users of morphine and methadone suffer serious, if less easily recognized, effects for up to 6 months after withdrawal. Notably, a long-term, increased response to pain stimuli has been recorded in both animals and humans. "We have reason to believe," says Martin, "that a protracted abstinence syndrome may exacerbate some psychiatric defects in psychopathic personalities."

Asked to define the "addict psychopath," a term which appears with some frequency in the literature, Martin says that it means those addicts—and a lot fit the criteria—who, when tested, show an elevation on a scale used to indicate psychopathic personalities. With addicts, common characteristics tend to be immaturity, poor self-image, and an inability to delay self-gratification. The relation between the protracted abstinence syndrome and the relapse syndrome is obviously important and is one of the things Martin and his staff will continue to work on.

The Role of Prisoners

There are plenty of other things for the center to carry on with, but the world outside the ARC is changing. At a time when experimentation with human subjects is under sharpening scrutiny, the use of prisoner volunteers in narcotics research can be expected to turn up on the critics' agenda. The ARC has so far not come under serious attack, and Martin says that ARC's careful procedures in selecting volunteers, in having outsiders review study proposals, and in maintaining high standards for patient management should allow the center to operate comfortably under the National Institutes of Health's new guidelines on protection of human subjects.

Unquestionably, however, increasing pressures will be exerted on ARC from several directions. Human rights advocates will, predictably, take up the case of prisoner volunteers, who form one of the categories of subjects with whom the problem of consent is especially complicated. On the other hand, criticism is already being heard that narcotics research using human subjects should be permitted in other places besides Lexington in order to break a "monopoly" which has restricted the scope of narcotics research.

Certainly, studies of the era of the Eddy dispensation should enrich the sociology of science. And narcotics research is now in the process of being "opened up" in a number of ways. Whether this will fundamentally affect the ARC seems doubtful, even though many professionals in the field of addict treatment and narcotics research have conflicting feelings about the use of prisoner subjects in addiction studies. Typically, they will express reservations about using prisoners as "human test tubes," as one psychiatrist put it, but at the same time they acknowledge that the work at ARC is "necessary." Narcotics research at the ARC and elsewhere is one of those sectors of science where there is rather wide agreement on ends, but where it is necessary to keep a watchful eye on means.

—JOHN WALSH

Genetic Erosion: Crop Plants Threatened by Government Neglect

The Bible has long told us that we shall reap what we sow, but for more than a decade plant geneticists have been warning government officials that we may not be able to reap anything at all unless we save.

Specifically, scientists have been advocating the preservation of plant genetic resources—the seeds of plant and food crops from which new crops are developed and existing ones are protected against disease—through a systematic, comprehensive, and international network of seed banks, or seed storage centers. But the warnings have gone largely unheeded. Most nations have not developed seed banks, and the U.S. National Seed Storage Laboratory is overcrowded, understaffed, and sorely in need of funds.

Despite recent manifestations of increased concern about seed conservation, a U.S. Department of Agriculture (USDA) study issued last month warns that "The [genetic resource] situation in serious, potentially dangerous to the welfare of the nation, and appears to be getting worse rather than better."

During the last decade, urbanization, economic development, and major advances in crop production have hastened the disappearance of thousands of genetically varied strains of plants and crops, products of thousands of years of evolution. In the mid-1960's, the so-called Green Revolution began to spread through vast reaches of agricultural land in Latin America, Asia, and the Mediterranean nations, bringing harvests of new "miracle" wheat and rice strains that promised to forestall global food shortages. In countries where the new, high-yield grains have become established, they have rapidly supplanted the native varieties. Many of these native varieties have not been collected and preserved and are dying out. No one knows how many may have become extinct. Thus, the array of strains on which future plant breeding depends has been dangerously narrowed, resulting in what plant geneticists call "genetic erosion." Moreover, mass planting of a single strain of rice or wheat creates genetic uniformity, which, in turn, makes the crop more susceptible to an epidemic.

The United States and other nations have been given ample warning of the