

says Amos. This is one reason why, in spite of the tremendous interest in using the technique, very little is yet in print. Terry Burke, of the University of Leicester, also points out that it is dangerous to assume that the band pattern produced by the technique is in fact a fingerprint, that most of the bands represent independently inherited loci.

"You have to demonstrate you have a true fingerprint with each new species you look at," says Burke, "and this involves a lot of work, with several crosses." So far, he notes, data demonstrating true fingerprints have been published only for human, dog, cat, mouse, and the house sparrow, although some unpublished data exist, including that for the European bee-eater.

In spite of these caveats, many researchers are pressing ahead, and results are beginning to come into the literature. For instance, Burke and his colleague M. W. Bruford have already demonstrated that about 20% of house sparrow chicks in the nests of apparently monogamous pairs are fathered by other males. The female is deceived on occasion too, when another female lays an egg in her nest, a trick known as intraspecific parasitism. In both cases, the reproductive success of the adults on the nest is lower than would have been calculated from field observations—unless they have been plying similar tricks elsewhere.

Davis, in collaboration with Burke, is soon to publish data on the hedge sparrow, whose mating system is very much more complicated. The results give a clearer insight into true reproductive success in this species and demonstrate that the birds' behavior is finely tuned to that parameter, even though the fit is not perfect.

These investigations rely on the ability of fingerprint data to identify parent-offspring relationships, which is not very controversial. In their work with the bee-eaters, Krebs and his colleagues stray into uncertain territory, that of detecting more distant relationships. "In our population we have about a 20 to 30% sharing of bands by chance, which means that we are fairly confident of identifying full siblings," says Krebs. For their purposes, this represents an acceptable level of background noise. "First cousins, with 12.5% genetic relationship, would be more difficult to detect, but we would not expect a significant degree of help at the nest with this distant a relationship."

The clash between high expectations and pedestrian reality is imminent in the joint DNA fingerprinting/behavioral ecology endeavor. Some problems will be solved readily, others will not, but overall it does represent major progress. ■ ROGER LEWIN

Drug-Resistant Strains of AIDS Virus Found

The emergence of AZT-resistant strains of the AIDS virus in patients treated with the drug has serious implications for treating AIDS and preventing its spread

THE BURROUGHS WELLCOME CO. announced last week that prolonged treatment with AZT, the only drug now approved for combating AIDS infections, can lead to the emergence of drug-resistant strains of the AIDS virus. The appearance of the AZT-resistant strains was not associated with any marked decline in the patients' conditions, and clinicians say that AIDS patients who are taking the drug do not need to change

The AIDS virus becomes progressively more resistant to AZT as time goes on.

their treatment regimens. The new findings, which will be published in the 31 March issue of *Science*, nonetheless have serious implications for efforts to treat AIDS and prevent its spread.

For one, the findings point up the need to develop new drugs for AIDS therapy. "If it [AZT resistance] turns out to have a clinically relevant correlate, we will have to develop alternatives, or use drug combinations," Anthony Fauci, the director of the National Institute of Allergy and Infectious Diseases, said in an interview with *Science*. Several potential AIDS drugs are being evaluated in clinical trials, but are not yet widely available to patients. The people taking AZT currently number in the thousands, perhaps in excess of 20,000, according to a spokeswoman for the Burroughs Wellcome Co.

Moreover, as many as 1.5 million people in the United States may have been infected by the AIDS virus, but have not yet developed the full-blown immunodeficiency syndrome. Clinical trials to determine whether AZT can delay or prevent the development of AIDS have been started. The discovery of the drug-resistant virus variants raises the possibility that, even if the progression of the disease can be postponed, the virus that ultimately produces symptoms might not be so readily controlled by AZT. Also worri-

some is the possibility that the resistant AIDS virus variants might be transmitted to more people.

The AZT-resistant viruses were identified by Brendan Larder and Graham Darby of Wellcome Research Laboratories in Kent, England, and Douglas Richman of the University of California, San Diego, and the San Diego Veterans Administration Medical Center. The researchers obtained isolates of the AIDS virus, which goes by the scientific name of human immunodeficiency virus 1 (HIV-1), from patients who had been taking AZT for varied lengths of time up to 30 months and from patients who had never received the drug.

The isolates from 5 of the 15 patients who had been on the drug for more than 6 months were markedly—as much as 100 times—more resistant to the growth inhibitory effects of AZT than isolates from untreated patients and from those who had taken the drug for less than 6 months, Larder says. Moreover, two or more sequential isolates had been obtained from a few patients, and these showed that the AIDS virus becomes progressively more resistant to AZT as time goes on. The way in which the AIDS virus acquires the resistance is currently unknown.

At present, there is no direct evidence linking the development of AZT resistance to a worsening of the patients' symptoms. The patients producing the resistant HIV-1 variants did not, for example, show increased blood concentrations of the viral antigen p24. This suggests that virus reproduction had not gone up in the patients.

Clinicians often find, however, that the condition of AIDS patients begins to deteriorate within 6 to 18 months after they begin taking the drug. "The drug is clearly effective. The responses in many people are dramatic, but they are short-lived," says Jerome Groopman of New England Deaconess Hospital in Boston. "It's terribly important to know what the biological basis of the clinical progression is." The development of AZT resistance is one possible cause, but not the only one.

Larder points out that the current study,

which included only a small number of patients, was not designed to assess the clinical impact of viral resistance to AZT but simply to ask whether such resistance was developing. "We've answered that question," he remarks, "but the wider question will require a lot more study."

The emergence of the AZT-resistant strains of the AIDS virus comes as no surprise. Cancer cells often develop resistance to the drugs used for cancer chemotherapy, just as bacteria become resistant to antibiotics such as penicillin. "When you treat a microorganism with the ability to mutate, you select out resistant variants. The AIDS virus mutates very readily," Fauci notes. At least two additional groups have presented data at AIDS meetings that indicate that HIV-1 becomes resistant to AZT in patients taking the drug.

To combat the development of resistance, combinations of drugs with different modes of action are frequently used in cancer chemotherapy. "We wouldn't rely on any one drug. The odds of developing resistance to a combination are much stiffer," says Samuel Broder, director of the National Cancer Institute and one of the clinicians who helped develop AZT for AIDS therapy.

Combination drug therapies for AIDS are under investigation. One of the more optimistic findings by Larder and his colleagues is that the AZT-resistant virus strains retain their sensitivity to three other drugs that are being tested in AIDS patients.

New AIDS drugs are needed, and not just because AZT therapy is, for whatever reason, only of temporary benefit for many of the patients who receive it. Some 50% of the AIDS population either cannot take AZT at all or must take reduced doses because the individuals cannot tolerate the drug's side effects, such as depression of blood cell formation by the bone marrow.

At the behest of British health officials, the Burroughs-Wellcome Co. sent a letter on 13 March to the physicians who prescribe AZT to alert them of the new findings about the emergence of drug-resistant strains of the AIDS virus. On 14 March, the company issued a press release that gave a brief summary of the resistance study results and also notified the London Stock Exchange, where its stock is traded, about the results. This notification is required of any company that expects a large change, whether a decline or increase, in the price of its stock.

Because company officials thought that they were morally and legally obligated to take these steps, *Science* did not oppose the early release of the information, even though it violated the journal's normal embargo policy. ■ JEAN L. MARX

Treasuring the Moon for 20 Years

As the 20th anniversary of the first landing on the moon approaches this July, 98% of the moon rocks collected by Apollo astronauts await further study in the continuing effort to unravel the origin and evolution of Earth's nearest neighbor. Not that the 382-kilogram treasure trove of lunar samples has been gathering dust in the Planetary Materials Laboratory at the Johnson Space Center in Houston. It is just that lunar scientists are being parsimonious in the extreme.

Researchers have subdivided the original 2,196 numbered samples into about 70,000 pieces, each numbered and documented. About 56,000 subsamples of these have gone out for analysis, but thanks to the care of sample preparers, the nondestructive nature of many tests, and the sensitivity of modern analytical techniques, only 2% of the moon rocks have been consumed. From that tiny investment, researchers have learned that the moon is as old as Earth and the meteorites, that it formed under dry, reducing conditions, that it once had a magnetic field, that it became layered early on, that a heavy bombardment by meteorites ended about 3.9 billion years ago, and that it has a dearth of iron-loving elements, among other insights. The moon rocks have not yet yielded all the answers; one lingering question is why there is a moon at all (*Science*, 17 March, p. 1433).

There seems little doubt that the moon rocks will be ready for the next 20 years of study. They are being kept under pure, dry nitrogen in a vault with walls of 45 centimeters of double-rebarred concrete and 6 millimeters of steel. The best safe-cracker would take 7 hours to open the vault's door. The vault is one-and-a-half stories above the ground and thus above the highest storm surge expected from the Gulf during 100 years. About 14% of the stash is actually in a vault in San Antonio to avoid having all the eggs in one basket.

If recent experience is any guide, the coming years of research on the moon rocks could be relatively quiet. About 700 to 900 samples, most of them only milligrams in size, are going out each year to the 65 or so investigator groups active in the field, 15 of which are outside the United States. But that is a far cry from the heady days of the early 1970s during the Apollo missions. Even the recent rejuvenation of lunar origin studies has not noticeably increased the steady rate prevailing since the late 1970s, according to Douglas Blanchard of the laboratory.

There are some signs of renewed activity. The same techniques developed for storing, handling, and sampling the moon rocks are being applied at the laboratory to the meteorites collected from the Antarctic ice, a few of which were blasted off the moon and perhaps Mars, and to interplanetary dust collected in the stratosphere. And there is the perennial hope that a satellite orbiting over the moon's poles could extend the results from local Apollo sampling to the whole moon. ■ RICHARD A. KERR



A part of the treasure. These moon rocks were part of the first load returned by Apollo astronauts. This July will mark their 20th anniversary on Earth.