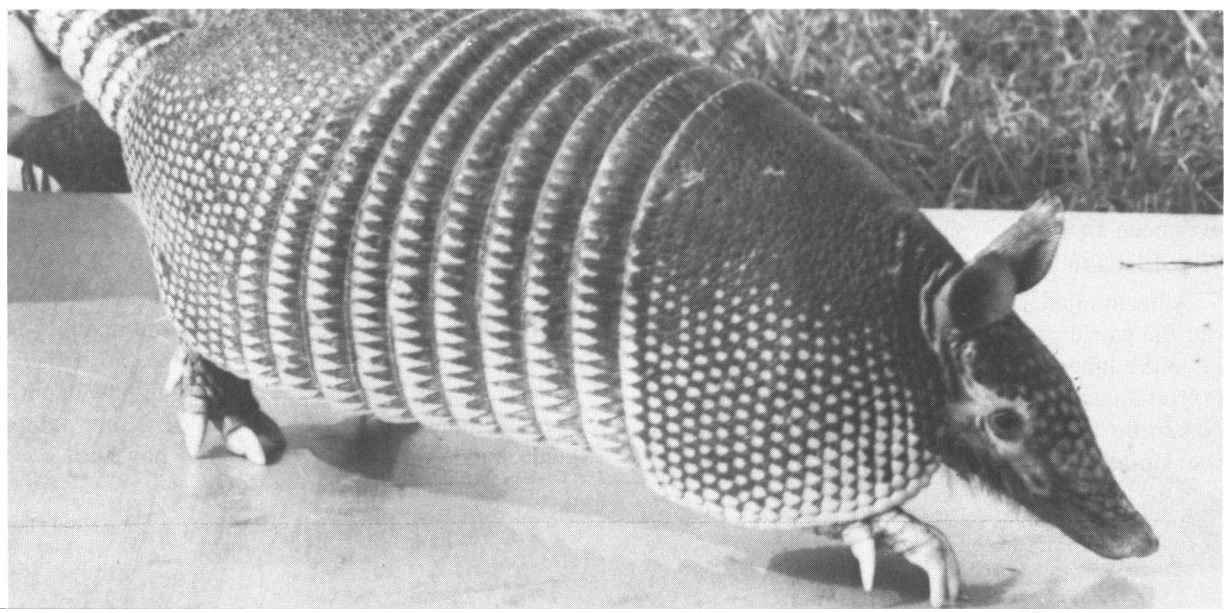
The Federal Health Programs Service and the Center for Disease Control of HSMHA and NIH's National Institute of Allergy and Infectious Diseases and Division of Research Resources is providing support toward developing an acceptable experimental animal for leprosy research. Tearsheet requests to George D. Bragaw, Federal Health Programs Service, 5600 Fishers Lane, Rockville, Md. 20852.

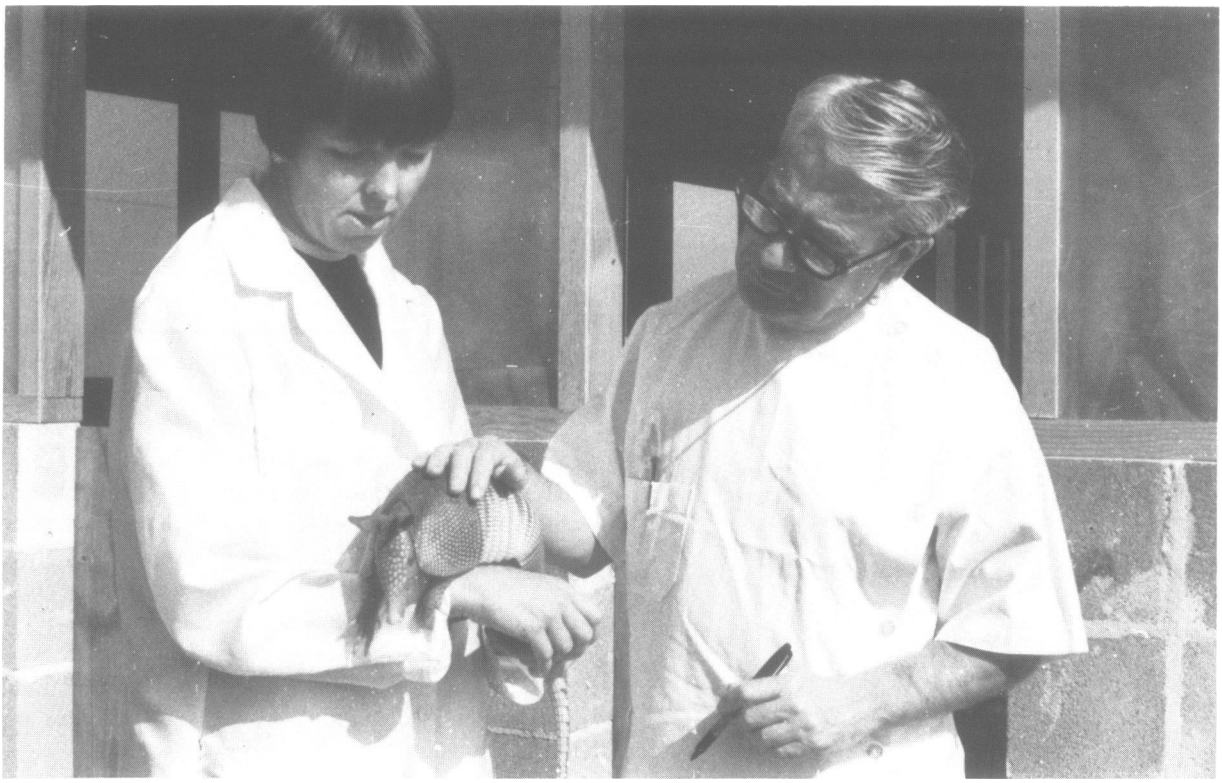
Armadillo May Aid Leprosy Research

The successful infection of a nine-banded armadillo (*Dasypus novemcinctus*) with leprosy (Hansen's disease) has aroused hope that a suitable experimental animal for study of this disease has finally been found. Dr. Waldemar F. Kirchheimer, chief of laboratory research, Public Health Service Hospital, Carville, La., collaborating with Dr. Eleanor E. Storrs of the Gulf South Research Institute (GSRI), New Iberia, La., injected four armadillos with *Mycrobacterium leprae* in February 1970. A little over a year after the injection, one middle-aged animal showed clinical signs of lepromatous leprosy and died in July 1971.

The scientists first reported this development at the Joint Leprosy Panel Conference of the U.S.-Japan Cooperative Medical Science Program held on the National Institutes of Health campus in late July 1971. Finding an acceptable animal model for leprosy research has been a major goal of the U.S.-Japan program and of leprosy researchers everywhere.

An armadillo captured on Carville hospital grounds





Dr. Storrs and Dr. Kirchheimer examining an armadillo

The disease manifested itself in large sores on the animal's earlobes, where 8.9 million live bacteria taken from a patient in Surinam, South America, had been injected. It spread throughout the animal's bloodstream, nerves, skin, and vital organs.

After its death, the animal was brought from GSRI's Atchafalaya Basin Laboratory in New Iberia to Carville for necropsy. Studies of the animal's tissues revealed a far more serious case of lepromatous leprosy than has ever been observed in man. Kirchheimer found that the bacteria that cause leprosy accounted for 2 percent of the total weight of the armadillo's earlobes—20 billion bacteria for each gram of earlobe. "The numbers are fantastic," he said. "That's five times more than in the worst case of human leprosy that has ever been known."

The Disease in Man

An estimated 15 to 20 million persons throughout the world probably have leprosy. The majority have the tuberculoid, rather than the more serious lepromatous form of the disease. Leprosy does not constitute a significant public health problem in the United States in terms of numbers affected. Unfortunately, for this very reason, Dr. John R. Trautman, director of the Carville hospital, has pointed out, U.S. physicians tend to omit consideration of the disease when such consideration is indicated.

Leprosy attacks the skin and nerves and mimics other skin diseases. Numbness of the skin to pain is generally the earliest symptom. A peculiarity of the infection is that clinical disease develops in relatively few of the persons exposed to it. Some researchers, including Kirchheimer, have suggested that these persons may have a defect in their cellular defense against the leprosy bacillus. Moreover, the ability of human tissue to resist the disease is very high; of all those who become infected and show early symptoms, probably 70 to 75 percent recover spontaneously. Leprosy in itself seldom, if ever, proves fatal to man since it strikes no vital organs.

Blocks to Research Progress

Research has been hampered by the inability to cultivate the leprosy bacillus in vitro on artificial culture media and the lack of a suitable experimental animal. *M. leprae* is one of a few pathogenic bacteria that microbiologists have not been

able to cultivate in the test tube although it was the first disease-producing organism to be found (1874), and its discovery proved to be an important advance in the science of microbiology. It provided the impetus for Robert Koch's discovery in 1882 of the closely related organism that causes tuberculosis.

The failure to find an animal susceptible to leprosy has largely limited the search for effective drugs and other methods of treatment to human subjects, with all the accompanying dangers. Experiments with animals, however, have been done for years. In some recent investigations, the natural immunity of mice to leprosy was modified through radiation. Also, a technique, developed a decade ago at the Center for Disease Control, that permits the leprosy bacillus to be cultured in the footpads of mice, has been used extensively to test new drugs. The infection thus stimulated does not, however, spread beyond the site of the injection of the bacilli, and the mouse must be severely altered to enhance the infection. In addition, the short lifespan of the mouse—only about 2 years—is a disadvantage since leprosy develops slowly.

Selection of the Armadillo

When Kirchheimer learned that Storrs was trying to develop the armadillo for various research programs, he became interested in collaborating with her in a project designed to test the potential of the football-sized mammal in leprosy research. The armadillo offers the leprosy researcher several advantages over the mouse.

The armadillo's skin and body temperature is very low for a mammal and readily affected by ambient air. Researchers have previously shown that, in man, multiplication of *M. leprae* is more pronounced in the cooler parts of the body tissues. Temperatures of 32°C. are optimum for the organism's growth.

The animal has unique reproductive characteristics. Armadillos produce identical quadruplets at each delivery so that experiments can be repeated with genetically identical animals. Thus scientists could begin selective breeding of armadillos and try to produce two colonies of animals—one with heightened susceptibility to leprosy and the other resistant to it.

Moreover, because armadillos have a lifespan of 12–15 years, they live long enough to contract leprosy, a disease with a prolonged period of incubation and a slow and protracted course. Storrs pointed out other advantages of the animal for leprosy research—a 9-month period of gestation and immuno-suppressive mechanisms that seem to be relatively poor.

Storrs had first established a colony of armadillos in a converted toolshed behind her home in Blanco, Tex. Grants from the Division of Research Resources, NIH, and the Center for Disease Control, HSMHA, to the Gulf South Research Institute have enabled her to expand the animals' facilities and continue to adapt them in gradual stages to captivity. She has been assisted by Dr. William Greer, a veterinarian, who supervises the GSRI animal resources group.

Kirchheimer meanwhile sought to obtain viable Hansen's bacilli. A biopsy from a Carville patient with drug-resistant lepromatous disease was one source. Other biopsies arrived at Carville from physicians in South America, the Philippines, and Africa. After inocula had been prepared, some bacilli from each biopsy were injected into mouse footpads to test the organisms' viability. (Multiplication in the footpad after 6 months would prove the bacilli had been viable.) Then the inocula were rushed to New Iberia and injected into additional armadillos.

Future Possibilities

Seventy-seven armadillos, in all, have received injections of bacteria from leprosy patients. Kirchheimer expressed confidence that some proportion of these will prove to be susceptible to leprosy and develop the progressive form of the disease. The research with armadillos, he said, may lead to testing the theory that susceptibility is due to some genetic defect. Means of developing improved anti-leprosy drugs or even preventive methods may also result.

Dr. Chapman H. Binford, medical director of the Leonard Wood Memorial (American Leprosy Foundation) and chief of the Special Microbacterial Diseases Branch of the Armed Forces Institute of Pathology, commented that the development of a number of leprosy-susceptible armadillos might, in turn, help researchers in growing leprosy bacteria in the laboratory, a necessary step toward obtaining sufficient leprosy bacilli for more sophisticated biochemical and immunological investigations.

Dr. Jack Butler, director of the Federal Health Programs Service, which administers the Public Health Service hospital and clinic system, called the research team's successful infection of the armadillo "a significant advance in the long chain of events which we believe will ultimately lead to control or eradication of this dread disease."