1976 AA: Earth's Primitive, Fast-Moving Neighbor

Karl Reinmuth found the first one from Heidelberg Observatory in 1932—an asteroid on a path that carried it inside the orbit of the earth. He named it Apollo, and the known number of what are now termed Apollo asteroids has been slowly growing ever since. Number 19 was spotted late in December (SN: 1/17/76, p. 39), and now the list has reached an even 20. Number 20 is an appropriately distinguished candidate for such a milestone: "Fast-Moving Object Helin," named for its discoverer, planetary astronomer Eleanor Helin of the California Institute of Technology, follows a course that runs closer to earth's orbit than that of any other known object except the moon.

Furthermore, it is only the second known asteroid (number 19, discovered by astronomer Charles Kowal, was the first) whose most distant point from the sun is also in earth's vicinity, rather than out in the asteroid belt between Mars and Jupiter. Its orbit ranges only between about .79 and 1.14 times the earth's mean distance from the sun, about 73 million and 106 million miles, a path so earthlike that it circles the sun about 21 times for every 20 revolutions by the earth. It is tilted nearly 19 degrees to the plane of the ecliptic, however, so the paths of earth and Fast-Moving Object Helin (numerically known as 1976 AA) are intertwined like two nearly aligned links of a chain.

Polarimetric and radiometric studies at the University of Arizona have yielded light curves indicating that the object is a dark rock about half a mile across, according to Brian G. Marsden of the Smithsonian Astrophysical Observatory in Cambridge. The intriguing possibility is that it is the former nucleus of a now-defunct comet.

"If it is a degassed comet nucleus," says Eugene M. Shoemaker of Caltech, "then it represents one of the most primitive kinds of bodies that we can find in the solar system. By carefully studying its surface, we should be able to get clues as to how the solid matter precipitated out of the solar system's primordial nebula and was collected together into larger bodies on their way toward becoming planets." Shoemaker envisions a scenario in which the object formed during the birth of the solar system as a great carbonaceous rock, initially covered with ices. Close encounters with massive Jupiter, he says, could have bent its orbit into that of a long-period comet, followed much later by additional Jovian gravitational effects pulling it in to a short-period path. Finally, a close pass by the earth would have set 1976 AA on its present course. Throughout its orbital evolution, whenever it passed near the sun the heat would vaporize more and more of its icy coat, at last leaving the rocky core that now remains.

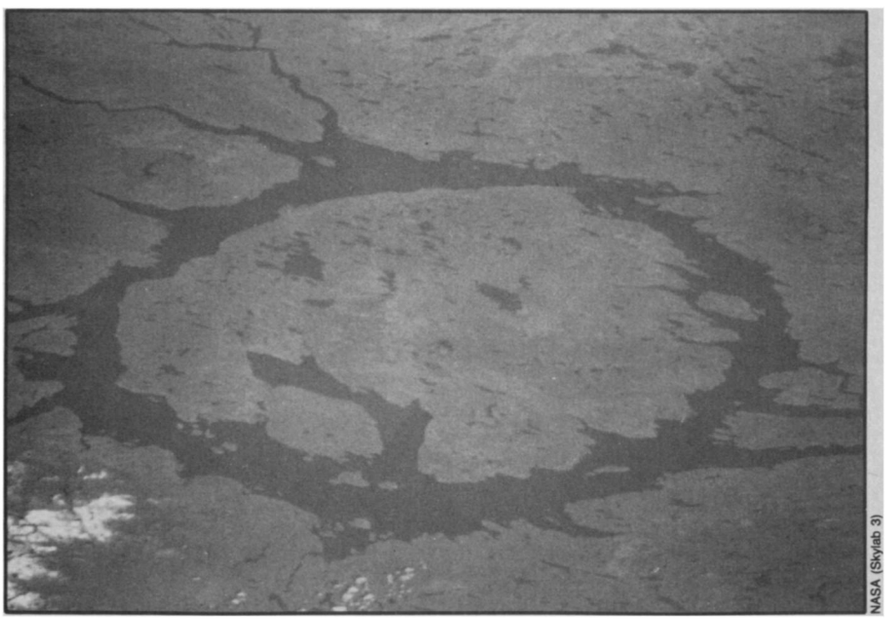
The object was discovered when it was near its closest point to earth, about 11 million miles. Its slightly—but only slightly—shorter orbital period means that it takes a long time to catch up with the planet again. "Even though it never strays far from the earth's orbit," says Helin, "it is near the earth itself only a few times every 20 years. This year and next it will be in good observing position, and then its position in relation to the earth will become less favorable." Even when it was discovered, however, its brightness was only of about magnitude 13.

Dim though it is, its occasional nearness to earth suggests a tempting possibility. "Aside from the moon, this asteroid is one of the easiest places to get to in our solar system," says Shoemaker, who heads an Apollo asteroid survey funded by the planetology program of the National Aeronautics and Space Administration. "The new Apollo asteroid provides a very attractive target for man's first venture into deep space."

Such a mission would be quite different from landing a man on the moon (in addition to having to fly 44 times as far), particularly from the viewpoint of the pilot. "He could land there in a simple way. Its gravity field is so small, it would be like docking with another spacecraft." It cannot be done just any time, however, and no one will be clamoring to start the project in next year's NASA budget. "Twenty years from now—in 1996—it will be back," Shoemaker says. "That will be the time to coast up to it in a spacecraft." If in fact the object is, as Shoemaker believes, "a specimen of what we consider to be a planetesimal—a building block of planets—the scientific reward of a manned or unmanned mission to this body could be very large."

There is also the possibility that the object will come to earth instead. But hardly by 1996. Over many tens of thousands of years, the gravitational attraction of several of the planets could shift its orbit so that it will intersect that of the earth. Over a still longer period, Shoemaker calculates, the average chance of its striking the earth is about one in 24 million per year, giving it, in other words, a mean life expectancy of about 24 million years. The chance of a collision in any given year is thus minute, but the odds that it will happen sooner or later, he says, are about three out of four.

If Fast-Moving Object Helin indeed pays a call, it should make quite an impression. "If it struck the earth," says Shoemaker, "it would make a crater about 20 miles across. The great Meteor Crater in Arizona is a scar left by a much smaller asteroid which hit the earth about 25,000 years ago." Although only 20 Apollo asteroids have been found in the 44 years beginning with Reinmuth's initial discovery, Shoemaker estimates that about 800 such objects of magnitude 18 or brighter are moving around the solar system in orbits that occasionally intersect the orbit of the earth. In the early days of the solar



Quebec's Manicouagan Reservoir, 40 miles across, marks an Apollo asteroid's grave.

system there were far more, and their gravesites today pock the surfaces of the worlds they helped to form, such as Mars and the moon. Even in more recent geological time the earth is struck an average of three times every million years by Apollo asteroids a mile in diameter (twice the apparent size of 1976 AA) or larger, says Shoemaker. Statistically, two of these objects will strike the ocean, but many of the land impacts of the past are still visible. The 17-mile Ries crater in Germany was born of one some 15 million years ago. About 1.3 million years ago, a six-mile impact crater at Lake Bosumtwi in Ghana was blasted into existence. Even larger features, some up to 40 miles across, are known on the North American continent.

Eleanor Helin first spotted 1976 AA on Jan. 7 (only 11 days after Kowal found No. 19—1975 YA), using the 18-inch Schmidt telescope at Palomar Observatory. She relocated it repeatedly on the two following nights. More than half a dozen other observers have seen it since, providing data that enabled Marsden of SAO and James Williams of the Jet Propulsion Laboratory to calculate its orbital characteristics. Spectrographic studies at the University of Arizona and the University of Hawaii have shown the asteroid to resemble a class of meteorites known as carbonaceous chondrites—stony objects containing about two to four percent carbon, often in the form of complex organic compounds, and pocked with spheroidal inclusions of such materials as magnesium-iron silicates.

The new find is not Helin's first such discovery. In 1973 she found one which still holds the record for the highest inclination, or orbital tilt, of any known Apollo asteroid: 68 degrees. It was seen only briefly, and Helin plans to look for it again late this year, although, Marsden points out, its orbit is so sketchily known that it may take a lot of looking. (Relocating the tiny objects, in fact, is a problem more often than not. Only nine of the 20, says Marsden, have been detected on return trips.)

There are known Apollo asteroids larger than 1976 AA—one called Sisyphus, discovered in 1972, is believed to be eight times as big, about four miles across—and others have come closer to the earth, though not in such elegantly matched orbits (Hermes, found in 1937, has come within half a million miles). But No. 20 is currently the focus of attention, drawing a growing number of watchers around the world. (IAU circulars 2899, 2901, 2903, 2905).

Meanwhile, a little more has been learned about No. 19. Observations since its Dec. 27 discovery have shown that Fast-Moving Object Kowal does not, as was first suspected, loop through the orbits of Earth and Venus. Instead, it loops through those of Earth and Mars (IAU circular 2903). □

Armadillos contract leprosy in nature

Armadillos, those armor-plated relics of the once great mammalian order Edentata, are catching what appears to be human leprosy in the American South. And no one is particulary surprised—least of all leprologists and edentologists. They are, in fact, fairly happy about it on one level, albeit worried on another.

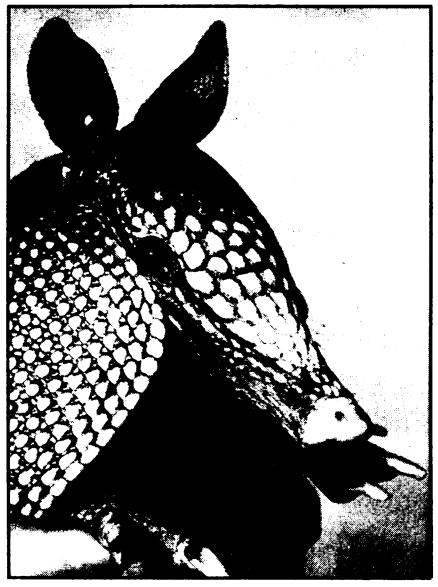
The nine-banded armadillo is a relative newcomer to the southern United States —a migrant worker, one could say, from Mexico, in search of the insect pests in farmer's fields. The climatic heat wave in the Northern Hemisphere during the first half of the century allowed their northward spread. And those that didn't wander to parts of Texas, Louisiana, Florida, Arkansas and Alabama by themselves were imported by farmers.

Along with sloths and anteaters, they are the most primitive living mammals, and share with the others a somewhat inefficient internal heat regulator that is sensitive to external temperatures. It is this primitive heat control that allowed both the migrations and, it turns out, the susceptibility to leprosy.

The same research group that now reports finding leprosy in wild armadillos in the JOURNAL OF THE RETICULOENDOTHELIAL SOCIETY (18:6) discovered that susceptibility experimentally five years ago. Eleanor E. Storrs of the Gulf South Research Institute in New Iberia, La., in collaboration with researchers at the U.S. Public Health Service Hospital at Carville, La., was able, in 1971, to infect armadillos with *Mycobacterium leprae*, the infectious bacillus that causes leprosy in humans (SN: 9/4/71, p. 138). Storrs knew 1) that *M. leprae* grows at lower than body temperatures (the reason it invades the cooler extremities and skin) and 2) that armadillos have a body temperature of 87 to 92 degrees F due to their poor heat regulation. She suspected that armadillos could be infected with the leprosy agent and serve as a badly needed animal model for studying the disease. And she was right. Leprologists have used armadillos in basic research ever since.

But now, Storrs, colleague Gerald P. Walsh and others from Gulf South Research have discovered that armadillos in the wild had the disease all along. They captured seven animals in isolated areas of Louisiana and found, after routine examinations, that they had skin lesions, enlarged lymph nodes, nerve degeneration and diseased spleens and livers. Microscopic examination and biochemical tests revealed a mycobacterium in the diseased tissues. More tests, done since the report appeared in December, have confirmed that at least in one animal thus far, the organism is *Mycobacterium leprae*, the human leprosy agent.

The significance of the finding extends well past the superficial concern that



Armadillos: Leprosy from dirt or insects?

humans come into contact with armadillos on occasion. (More than occasionally, in some cases. The students at the University of Texas have, for example, adopted the armadillo as their counter-culture mascot.) "The most important thing," Walsh told SCIENCE NEWS, "is that suddenly, we find that a reservoir of human leprosy bacillus exists in nature." It was believed until now, he says, that prolonged contact with another leper was the principal, and possibly only, means of transmission. The finding may lead, therefore, to a new understanding of how leprosy is transmitted.

The armadillo, in his natural swampy habitat, eats mainly insects and dirt. The team is now studying both for traces of the human leprosy bacillus. "We don't want to start a panic," Walsh says, "since it is clear that only a small percentage of people are susceptible to leprosy in the first place." (An estimated 10 to 15 million persons now have the disease, 3,000 of them in the United States.) "But," he says, "we are going on the assumption that armadillos and the suspected natural reservoirs should be handled with care."

A species of Bolivian frog, a few rodents and the water buffalo have been reported by other researchers to contract leprosylike diseases caused, most likely, by mycobacteria (bacteria that invade other cells with hairlike appendages). The armadillo, however, is the only animal that shows positive results to tests used to diagnose human leprosy—more evidence that they do catch the same disease.

One lead to natural reservoirs of *M. leprae* may be to investigate rice fields. It is known that the incidence of human leprosy is higher in rice growing areas and where rice consumption is high. It may be signficant that the seven armadillos with leprosy were found near rice growing areas of Louisiana. □