SCIENCE NEWS
OF THE WEEK

Lust for Life

The chance of life in space is a constant goad for scientists

In 1947, Idaho businessman and pilot Kenneth Arnold reported seeing strange objects flying through the sky, behaving, he said, like saucers skipped across a pond. Inadvertently, he had provided a name for thousands of unidentified flying objects to come, as well as sightings dating back hundreds and possibly thousands of years ("Ezekiel saw the wheel . . . ").

Since the christening of the flying saucer, the study of such phenomena has become the most publicized, if not the most scientific, aspect of man's search for life on other worlds. The U.S. Air Force's tiny UFO-watching project, Bluebook, has been receiving about 1,000 sighting reports a year for some time, although less than three percent of them are listed as unexplained. In 1967, for the first time, the Russians admitted to a rash of sightings.

While the debate rages furiously over whether earth is actually being visited by intelligent beings from space (one recent theory has it that the saucers themselves are living creatures), many scientists are more concerned with taking the mountain to Mohammed—seeking out extraterrestrial life on distant planets in our solar system and among the stars. At the 134th annual meeting of the American Association for the Advancement of Science, held in New York Dec. 26-30, a group of these scientists gathered to discuss the state of their art—and found it gloomy.

The U.S. has made only one official attempt to detect life in space, and that was nearly eight years ago. Called Project Ozma, it used the 85-foot radio telescope of the National Radio Astronomy Observatory in Greenbank, W. Va., to listen for possible intelligent-sounding signals that might be coming from deep space. Ozma aimed at only two or three stars, on only one frequency, says Harvard's Dr. Carl Sagan. It involved only 150 hours of listening time. The project was shut down, he declares, largely because of adverse public reaction due to heavy press coverage which implied that the telescope was also being used to send signals into space as well as listen for them.

This was thought to be a grievous waste of the facility's time, Dr. Sagan says, and it would have been. However, no transmitting was ever attempted and Ozma only took a fraction of the telescope's operating time.

The scientists' other grievance, hardly a unique one, is money. The National Aeronautics and Space Administration's war-torn budget is just about in shell-shock by now, and plans leading up to landing life-detection experiments on Mars or other planets have probably been delayed a minimum of five years. NASA has a full-time exobiology division, but its budget, which is essentially the entire U.S. Government bankroll for life-hunting in space, amounts to a miniscule $3.3 million a year. This is less than a tenth of one percent of NASA's total appropriation.

By contrast, says Dr. Sagan, the Soviet Union now has a State Commission for the Investigation of Extraterrestrial Intelligence, which holds weekly seminars and presumably carries on a vigorous program of research.

There's at least one obvious reason for the difference between the two countries, according to Dr. Bernard Wagner, who serves triple duty as a pathologist with Columbia and Rockefeller Universities and the National Institutes of Health. Some 40 percent of the members of the Soviet Presidium have earned scientific degrees, he says. "But in the U.S. Congress," he adds acidly, "you may have to show an animated cartoon to get some money for your program."

Dr. Wagner, by trade a researcher into human medical problems, but deeply interested in extraterrestrial life and in the millions of people — from scientists to flying saucer addicts — who wonder about it, represents a common position among extraterrestrial life investigators. "Almost nobody's in it full time," says Dr. Sagan, himself a planetary astronomer and at 33 already one of the leaders of the hunt. Another part-timer is Dr. Henry D. Isenberg of New York State University's Downstate Medical Center, whose chief concern is with earthly microorganisms and their effects on geological formations. But Dr. Isenberg's ideas about life in space extend decades into the future.

Blaw-Knox

Project Ozma, the only official U.S. space life hunt, took 150 hours in 1960.

Seeding Dead Planets

Finding life on another world would be one of the most significant events in the history of science (and religion, and philosophy), but an absolutely dead planet with no life at all would make Dr. Isenberg just as happy. Such a planet, he believes, might actually be colonized by microorganism sent from earth, until after many years it might even be made inhabitable for man.

Before any such steps could be taken, however, the planet would have to be proved to lack life forms—even primitive ones—of its own. Otherwise, there would be the danger of irreparably altering life on another world by contaminating it with earthly microorganisms against which it had built up no defense. Both U.S. and Russian space probes aimed at the moon or other planets are sterilized to prevent such contamination.

Planting life on another planet would be an extremely ticklish proposition, according to the scientist. "You can't just go up there with a saltshaker and sprinkle bugs," he says. The first step would have to be an investigation, perhaps using a roving vehicle that could travel over the planet's surface, to see whether any organic chemical compounds were present. These compounds are the basis of life on earth.

Then the first microscopic colonists, which Dr. Isenberg calls "pioneers," would be sent to the lifeless planet. If no organic compounds had been found, the first microorganisms would be those which can feed on inorganic compounds to produce organic by-products, which in turn could be used as food by the second batch of microorganisms. These might follow months or years later, and would simply serve to increase the size of the colony. If the colony appeared to be taking hold, then more sophisticated colonists—perhaps algae—might follow.

As the size of the colony expanded, the planet itself might begin to change. Water and carbon dioxide given off by the tiny colonists could actually increase to the point where they would form clouds in the atmosphere, Dr. Isenberg says. This in turn could affect the amount of sunlight reaching different parts of the planet's surface, and the resulting irregular heating could create entirely new wind patterns.

"It is within man's capability," Dr. Isenberg says, "to make uninhabitable planets inhabitable, provided there is enough gravity to retain an adequate atmosphere." Even if men are never able to live on them, he adds, it may still be possible to convert the lifeless worlds into remotely harvested farms.

The biggest problem however, might well be picking the right world in the first place, and making sure it had no life forms of its own. If a space probe were to land on the Sahara, for example, says Dr. Isenberg, "it might well report back that there was no life on earth."

To make sure of the absence of life could require wide-ranging experiments covering large areas of the planet's surface. One such test might be to deposit glucose — a primitive sugar used as food by many simple organisms —in several locations and use automatic monitoring devices to watch for any decreases or other changes in it that might signal the presence of life.

Sending live microorganisms even to a dead planet, however, would be certain to arouse the wrath of some scientists. One objection would be that no experiment could absolutely guarantee the absence of life. Other complaints might be heard from, for example, geologists, fearing that chemical changes caused by the addition of life would alter some of the planet's scientifically valuable features.

Several scientists at the AAAS meeting pointed out that until a few hundred million years ago — relatively recently compared to earth's estimated age of 4.5 billion years—there was only a tiny bit of oxygen in the atmosphere, not nearly enough for men to breathe. It was not until photosynthesis became widespread with the growth of green plants that oxygen levels rose appreciably. "If we had come upon the earth four billion years ago," Dr. Isenberg says, "it would certainly have looked inhospitable for supporting human life."

Primitive or Advanced

If man does find life somewhere in space, it will almost certainly be one of two types: either simple, primitive microorganisms or an advanced technical civilization. Biological life-detection devices only detect microorganisms, and if the extraterrestrial equivalent of a dog comes along and licks one, it will still detect only the microorganisms on his tongue. On the other hand, any life that can make itself known from another star system would have to possess a good deal of technical proficiency.

Though Dr. Sagan argues that "we can't rule out life on any planet in the solar system," the chance of such life being intelligent on any planet but earth is virtually nil, according to Dr. Everett M. Hafner of the University of Rochester, N.Y. There are hundreds of millions of stars in our galaxy, however, and Dr. Hafner estimates that one in every 100,000 of them could harbor a planet with a civilization advanced enough to send its own life-seeking signals out into space. In fact, Hafner says, advanced civilizations are all we'll find if we find anything, since detecting a microorganism 100 or more light years away is just about out of the question.

If spacemen somewhere were trying to contact earth—or whoever else was listening—how would they go about it? "The problem," says Sagan, "is one of anti-cryptography; that is, those guys have the problem of inventing a code so simple that any boob could understand it."

Finding a Code

World War II produced some almost uncrackable codes, but finding an ultra-crackable one seems to be not so easy. One idea, already tried out by an informal group of scientists through the mail, is repeatedly to send out a series of dots that add up to the product of two prime numbers, such as 551 (19 times 29). To a scientist, Sagan says, the intelligence behind such a message would "leap right out." Another idea, Hafner suggests, is that an intelligent technological society out there might call attention to itself by monitoring and reporting variable features of nearby stars, such as flares from earth's sun. Thus man might keep an eye out for a signal that varies according to past features of the sun's 11-year cycle of activity.

The solar cycle is certainly prominent enough that an advanced, reasonably nearby civilization could see it, Sagan agrees, but he believes it would make a poor choice for a code. It simply wouldn't occur to anyone to check a signal from space against such a phenomenon, he says. True enough, says Hafner, but such a code would not be discovered except by accident anyway, since the correlation with the sun would probably only turn up in the course of some routine astronomical work, not as a result of a concerted search.

Right, says Sagan again, and that's why Ozma-style listening to outer space is such a reasonable idea. It need only take a tiny part of a radio observatory's time, and perhaps none at all, directly.

A variety of other codes have been proposed in the past, including additions, subtractions, square roots and arithmetic progressions, and most such would be conspicuous enough, according to Sagan, that they would stand out from general astronomical noise.

Detecting microorganisms within our own solar system, however, requires more than simply looking for patterns on a roll of chart recording paper. Without extremely sophisticated equipment, in fact, it would be almost impossible for a Martian to detect life on earth. A variety of experiments have already been designed, and the scientists behind them are impatiently cooling their heels and making design refinements, waiting for some money to appear on the horizon so the instruments can be sent to their destinations.

"Really there's no such thing as a life detector," Sagan says. "There are only detectors for groups of preset assumptions about what life might be like." One of the most interesting of these assumption detectors is called Gulliver. Landed on a distant planet, it fires a series of miniature cannons, each containing a projectile attached to a length of sticky string. After a predetermined period of time, Gulliver reels in its strings, presumably with any nearby microorganisms stuck to them. Once inside the unit, the strings are scraped of any accumulations, which fall into a nutrient solution containing radioactive carbon 14. If there is life present, and if Gulliver's assumptions are correct, the life forms will consume the carbon and give off, as a metabolic by-product, radioactive carbon dioxide which can be measured with a geiger counter.

Other assumption detectors, with names like Diogenes and the Wolf Trap, are intended to observe life processes involving such substances as sulfate, phosphate and adenosine triphosphate (ATP). A detector for ATP would make use of the same chemical reaction that enables a firefly to light up.

In case someone should suddenly decide to send them to Mars, a number of these experiments have even been assembled into an integrated package called the Automated Microbial Metabolism Laboratory. The AMML could be put into flyable form for less than $10 million, according to Dr. Gilbert Levin of Biospherics Research, Inc., in Washington, D.C. The package, he says, would take up less than half a cubic foot, weigh only 15 pounds and could complete all its experiments on less than .0005 kilowatt-hours of power, with a maximum power requirement of 10 watts. NASA also has a multi-experiment design of its own, called the Automated Biological Laboratory.

The wet blanket is again the empty wallet. "The AMML would be an extremely ambitious undertaking right now," says NASA's exobilogy chief, Dr. Richard S. Young, "especially with zero dollars."

It's possible, all of the scientists admit, that everybody's assumption detectors could be based on the wrong assumptions, in which case nothing would show up at all. One oft-suggested possibility is that the target planet might have silicon-based life, instead of the carbon-based variety found on earth. Even today, Isenberg points out, there are some life forms on earth called silico-flagellates which, although carbon-based, contain silicon and can't reproduce without it. This means, he says, that in the earliest days of evolution on this planet, life tried out silicon in its search for a stable foundation.

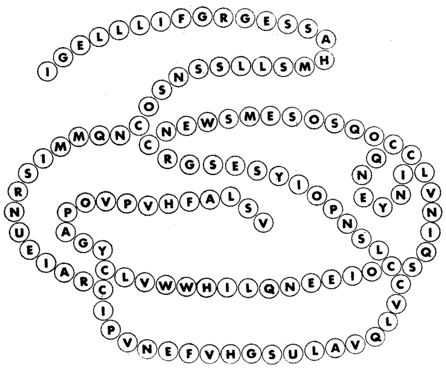
Silicon, however, is not stable enough for earth, or for any relatively warm planet, according to Sagan. At any temperature, he says, silicon compounds are less stable than comparable carbon compounds, and tend to undergo "randomization reactions" at high temperatures that would destroy genetic information needed for future generations. On low-temperature worlds, Sagan says, silicon-based life might, however, be a possibility.

There seems to be an abundance of ideas regarding what to do in the search for extraterrestrial life, almost as though everything has already been thought of. And it's almost true. "Conceptually we're fine," Sagan says. "It's the implementation that's holding us up." ◇

AN AAAS REPORT

Sequenator Opens Evolutionary Doors

Modern systems of species classification are based upon phylogeny — evidence of the evolutionary history of the organisms involved. The difficulty with this is that by "phylogeny" biologists mean genetic relationships between species and, at this point, these relationships are charted by inadequate, interpretative methods.



Jon Ahlquist

The sequenator spells out structure.

"There are no absolutes in this area," Dr. Charles G. Sibley of Yale University told the American Association for the Advancement of Science. "But," he said, "comparative protein studies will provide them."

The studies Dr. Sibley anticipates will be possible within three or four years when development of an automatic protein sequenator is completed. The protein machine offers scientists a new and precise technology for translating the genetic history books of life into real understanding of man's evolution. Speculative theories of evolution will be replaced by facts when researchers sort out the genetic web from which all living organisms come by reading the genetic history locked in proteins.

"With the aid of the protein machine we can compare the actual genetic recipes of living species," Dr. Sibley said. "We should be able to obtain an accurate index of their genetic similarities and of at least part of their evolutionary history. Even 10 years ago this would have been pointless daydreaming. Now we're on the brink of a new universe."

Development of a model protein sequenator which fulfills the daydreams of hundreds of scientists was announced several months ago (SN: 8/12/67) in the EUROPEAN JOURNAL OF BIOCHEMISTRY by Dr. Par Edman of St. Vincent's School of Medical Research, Melbourne, Australia. Now American scientists and instrument makers are perfecting the technology for mass production.

A protein is a large molecule made up of anywhere from 50 to several thousands of smaller amino acid molecules that can be assembled in an infinite variety of combinations. The amino acid sequence of each protein is a highly specific one, dictated by the gene that directs its manufacture. Knowing the sequence, scientists can read back to the gene that ordered it, and by comparing like proteins from various species, they can correlate sequence variations with genetic differences.

According to Dr. Sibley, many animals are placed in the same family on the basis of behavorial or physical similarities that may have evolved simply because the animals underwent the same process of environmental adaptation. Hence, fish and whales, birds and bats were once thought to belong in the same families. Contemporary research on genetic relatedness of falcons and hawks, often linked as "diurnal birds of prey," suggests they may actually be entirely separate species. "Their true relatives are as yet unknown," Dr. Slbley says. However, protein sequence comparisons will probably uncover their family trees.

Until now, scientists studying evolution have been plagued by barriers of technology. The tedious effort involved in analyzing and comparing protein sequences by hand methods has been simply too overwhelming to consider.