SCIENCE NEWS OF THE WEEK

The Genetic Basis of Sex Determination

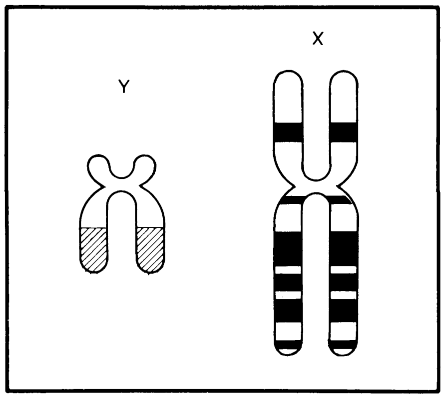
Human sex is known to be determined at the chromosomal level. If a fetus contains two X chromosomes in each cell, it will become a female. If it contains one X chromosome and one Y chromosome in each cell, it will become a male. However, it stands to reason that sex determination depends not just on the presence of a particular kind of chromosome, but on genes present on that chromosome. Research reported in the Nov. 20 NEW ENGLAND JOURNAL OF MEDICINE suggests that a major sex determinant gene may have been found.

Some years ago, investigators discovered that skin from a male mouse grafted onto a female mouse elicited an antibody response. Subsequently they found that the female mouse's antibodies were reacting to a particular antigen present on cells in the male mouse, but not in the female mouse. They named the antigen "H-Y" antigen, because it induced graft rejection. Last year, Stephen S. Wachtel of the Memorial Sloan-Kettering Cancer Center and his colleagues found that the H-Y antigen is present on the cells of the human male as well as on the cells of male mice, because male mouse antiserum to the H-Y antigen bound to male human cells. Consequently Wachtel and his colleagues decided to use a related serological technique to see whether the H-Y antigen might be coded by a gene on the human Y chromosome.

They took white cells from three men with abnormal chromosomal patterns—specifically two Y chromosomes instead of one in each cell. They put the cells in the presence of mouse antiserum to H-Y antigen. Then they put cells from men with the normal XY chromosomal pattern in the presence of the same kind of antiserum. The cells with the YY chromosomal pattern bound much more to the H-Y antibodies than did the cells with the XY chromosomal pattern, suggesting that the former contained more H-Y antigen.

The amount of antigen present on the cell surface is usually related directly to the number of determinant genes that are present. So in reporting their results, Wachtel and his team conclude: "The fact that human males possessing two Y chromosomes have excess H-Y antigen indicates therefore that a structural [gene] locus or positive regulatory locus for H-Y antigen is located on the Y chromosome in man. . . ."

The results of this particular study, in fact, are bolstered by several clinical observations Wachtel and his co-workers have made of women with a Y chromosome. These women had testes, and they had H-Y antigen on their cells.



Human Y and X chromosomes compared.

With one possible exception, this is the first gene to be assigned to the human Y chromosome. In an editorial in the same journal, Park S. Gerald, a physician at Children's Hospital Medical Center in Boston, hails the report as "a major event in human genetics." But even more intriguing and potentially important is the possibility that this gene may play a major role in sex determination.

Wachtel and his team explain why. During the past year or two, they have also found that the H-Y antigen is present in many different animal species, suggesting that the gene for this antigen has played a crucial role in evolution. What's more, they have found that the antigen is linked with sex within a species. For example, if the male in a species has the antigen, the female does not. If the female has the antigen, which is the case with birds and some amphibian species, the male does not. Now that they have found that the gene for the H-Y antigen is present on the human Y chromosome, they are all the more inclined to believe that it may be a major determinant of sex.

How might the gene determine sex? They speculate that the H-Y gene may be concerned with the development of the undifferentiated embryonic sex organs into either male or female sex organs, depending on the species. In humans, the H-Y gene would decide that the primitive sex organs become testes rather than ovaries.

Meanwhile, Wachtel and his co-workers want to learn more about the location of the H-Y gene on the human Y chromosome. They are studying the expression of the H-Y antigen in persons with structurally modified Y chromosomes to learn more about the precise location of the H-Y gene. For instance, they recently observed one woman with Turner's syndrome. She had both an X chromosome and a Y chromosome and the H-Y antigen. The Y chromosome, however, appeared not to be a total chromosome, but only its short arms. If this was really the case, then the H-Y gene probably lies on one of the two short arms of the Y chromosome. They are now looking at a male patient whose Y chromosome consists of only short arms. If he too expresses the H-Y antigen, then they can be more confident that the H-Y gene resides on one of the chromosome's short arms.

Wachtel and his colleagues are also continuing to explore the H-Y gene's apparent role in sex determination. As Wachtel told SCIENCE NEWS: "We want to study strange animals, like the lemmings that dive into the sea. For some reason—it's not clear—the females of that species have both an X and a Y chromosome. They are normal females in every respect. They just happen to have a Y chromosome which does not make any sense in the context of what we understand about sex determination. But according to our theory, they should have no H-Y antigen, even though they have the Y chromosome. So far, we have looked at three of these lemmings, and none of them has the antigen." □

Requiem for a star—or baptism of fire

Out in the constellation Perseus a star is dying—or perhaps being born. Astronomers are not quite sure which, but there seems to be more opinion on the side of dying. Both births and deaths continually occur in the life of the galaxy. But the exact process under observation, which may be either the beginning of the formation of a planetary nebula (death throes) or the last stages of the implosion of an interstellar cloud (birth pangs), is estimated to last no more than 25,000 years in the several billion that the average star survives. So the chance of catching one in either act is rather slim.

The object is an infrared source called CRL-618. (CRL is for the Air Force Cambridge Research Laboratory's catalogue of infrared sources.) It was identified by William E. Westbrook, a graduate student at the California Institute of Technology, who died before his paper could be published in the Dec. 1 ASTROPHYSICAL JOURNAL (not yet received at the time of this writing). Westbrook found CRL-618 during a search of infrared sources discovered in an Air Force rocket survey.

Apparently CRL-618 consists of an invisible, hot, condensed object with a surface temperature above 32,000 degrees. K. (the sun's surface temperature is about

6,000 degrees K.), surrounded by a dense cloud of gas and dust that does the actual infrared emitting. The star and associated cloud cannot be seen directly at visual wavelengths, but rather strangely they can be seen by reflected light. The reflection comes from two large dust clouds farther away from the object.

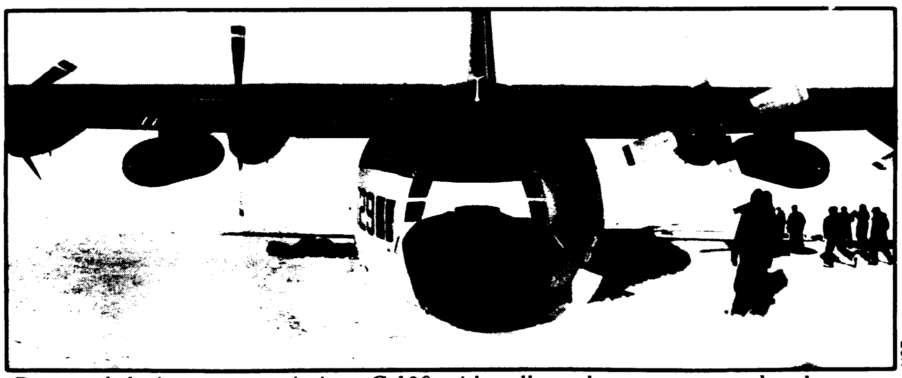
The dust cloud around the central object could either be imploding or exploding, an astronomical snapshot cannot for the moment tell which. But the reason for supposing that it is likely to be exploding and therefore the beginning of a planetary nebula is that CRL-618 is located above the plane of the galaxy about 3,000 to 6,000 light-years from the solar system, and that is a region where there should be little of the dust that condenses to form new stars.

The suggested scenario, therefore, is that CRL-618 is an ordinary star in the process of becoming a white dwarf, one of the generally accepted endpoints of stellar evolution. What happens is that the star has finished burning the hydrogen in its core. The core collapses, and the heat generated by the collapse blows off the outer layer to form a planetary nebula that gradually expands around the star.

About 600 such planetary nebula stars have been catalogued in the Milky Way galaxy—the Ring nebula and the Dumbbell nebula being the best known. But in all those, the planetary nebula has already reached a sizable distance from the central star. CRL-618 would be the first one caught just at the beginning.

Westbrook's work was part of a collaboration with Maarten Schmidt, Gerry Neugebauer and Eric Becklin of the Caltech faculty, K.M. Merrill of the University of California at San Diego, C.G. Wynn-Williams of Cambridge University in England, and another Caltech graduate student, Steven Willner. □

Rough flying for Antarctic research


NSF

Damaged during rescue mission, C-130 with collapsed nose gear nuzzles the snow.

When the first of Richard E. Byrd's Antarctic expeditions visited the bottom of the world in 1928, it arrived with three aircraft, one of which, a Fokker Super Universal monoplane, was abandoned in the frozen wastes when 150-mile-per-hour winds blew it away from a frozen lake in the Rockefeller Mountains east of Little America. Four aircraft accompanied the second trek in 1933, two of which crashed at Little America, and a third was so badly damaged while being loaded onto a ship for the return trip that it was scrapped when it reached the United States. Lincoln Ellsworth's first attempt to fly across Antaractica, in January of 1934, ended when his plane, the "Polar Star," was damaged by the breaking-up of the sea ice in the Bay of Whales. The first official U.S. Antarctic expedition of the 20th century, the Antarctic Service Expedition of 1939 to 1941, was forced to abandon two of its four aircraft.

Aircraft have been and still are vitally important to operations on the world's south polar cap—for supply, rescue, scientific research and general transport—but Antarctica has demanded a heavy toll. From the 1946 Operation Highjump, still the largest expedition ever sent there by any country, through the end of Operation Deep Freeze 1973, 50 aircraft were lost during U.S. operations, 20 of them helicopters. During the same period, 29 deaths resulted from aircraft accidents.

At the same time, costs—of research in general and of the aircraft themselves—have continued to grow. As a result, an ironic succession of mishaps this year has been "almost entirely" responsible, according to a National Science Foundation official, for reducing the number of U.S. scientific personnel in Antarctica by more than 50 percent. The U.S. Antarctic Research Program is funded by NSF to the tune of $29 million for fiscal 1976.

On Jan. 15, a U.S. Navy C-130 Hercules transport, engaged in support operations during preparation for core-sample drilling in the ice, was taking off from the site when one of its JATO (Jet-Assisted Take-Off) units exploded, causing the plane's right wing to burn off and destroying two engines in the process. The extra thrust provided by the JATO units is valuable in the thin air and icy terrain, where it enables the ski-equipped planes to take off in much shorter distances, saving vital time in runway preparation. Fortunately, no one was killed or injured in the accident—or in the ones to follow.

The same day, another C-130—they are the workhorses of Antarctica—was flown in to rescue the crew of the first, which included members of a French scientific party. It was decided that the plane would take off without using its JATO devices. But during the longer run over less-prepared surface the plane struck an icy hummock which completely collapsed its nose gear. A third C-130 successfully rescued both crews, but left behind at the site were more than $18 million worth of vital transportation—40 percent of the U.S. workhorse fleet on the frozen continent.

Few places on the planet's "land" area could be less inviting spots in which to conduct massive repair operations. The double disaster took place essentially in the middle of nowhere, about 650 miles from the U.S. base at McMurdo and slightly closer to Vostok, the Soviet base at the south magnetic pole. The elevation at the site is more than 7,000 feet above sea level, and the mean temperature is about 30 degrees F. below zero. At Vostok, the lowest known temperatures in the world have been recorded: a trans-shivering 126.9 degrees F. below zero. Summer in the Northern Hemisphere is the winter of winters in Antarctica, leaving a working season that runs only from about October through February.

A full-scale repair operation was obviously necessary if the two vehicles were to be salvaged. Lockheed, the planes' manufacturer, fabricated an entire center section for the ruined wing, but it would have to be installed in the field. The effort was not able to get underway until mid-October, when engineers, technicians and equipment began arriving at the site. Then, last month, on Nov. 4, the JATO unit on a C-130 being used in the operation broke free from its mounting, sheared into an engine and left a third crippled aircraft stranded in the cold.

It is also the least damaged of the three, points out Navy Capt. Eugene W. Van Reeth, who heads the Navy's Antarctic support program, and repair efforts are concentrating on it first. It will not be possible to complete work on the other two planes, however, until the next Antarctic summer, around the end of 1976.

The damage has not been confined to aircraft. The U.S. scientific complement in Antarctica, which included about 300 people last year, is down to little more than 100, says Guy Guthridge of the National Science Foundation. Most of the reduction is due to the costs involved in the recovery operations for the planes, as well as to the reduced airlift capacity for conducting and supporting research. "Many projects," says Guthridge, "were either curtailed or brought out of the field."