rockets, land mines and artillery shells.

They point out the difficulty of drawing a line between lethal and nonlethal chemical weapons since the incapacitating and presumably nonlethal gases, like all chemical and biological agents, are notoriously uneven in their dispersal and, therefore, in the amount absorbed by each recipient.

Equally deadly and far more difficult to control are the biological weapons now being tested, developed and stockpiled. Milton Leitenberg, scientific director of SCIENTIST AND CITIZEN, reports that men have "learned to produce them, to manipulate them, to disseminate them, but they have not learned to control them."

The issue also includes a review of the history of international control and U.S. policy; a discussion of the medical reports from Yemen, and problems in detecting biological weapons.

At the Anthropologists' meeting, Dr. Alexander Alland Jr. of Columbia University will stress the close link between warfare and disease. He chooses plague as an illustration because its occurrence is well documented, its cause is well known and it is a good illustration of a severe, highly contagious disease that is sensitive to ecological variation. It is endemic in Vietnam.

The agent of the plague is the bacillus Pasteurella pestis. It is a disease with a short incubation period and a high mortality rate. Wild rat populations normally harbor the fleas that spread the bacillus. Epidemics occur when the organism is passed on to domestic rodents that, because they are highly susceptible to the disease, rapidly die out. When this occurs, the fleas are forced to find new hosts, usually man.

The spread of plague in England, Dr. Alland notes, was facilitated by the destruction of woodland that was converted for agricultural purposes to feed a burgeoning population. The human invasion of the native habitat of wild rats brought the rodents into closer contact with domestic rats.

"The parallel between this situation and Southeast Asia is quite striking," Dr. Alland, one of the eight panel members, will state. The flood plains of the Mekong delta support one of the highest population densities in the world. Although epidemics of plague have not occurred for some time, the number of cases in Vietnam has mounted steadily during the past three years—from 119 to 4,453.

Dr. Alland suggests that defoliation and extensive napalm attacks have produced disturbances sufficient to increase the contact between wild and domestic rats. Although this is a conjectural theory, he says that such an explanation "fits well with current theories of plague epidemiology."

One major difference, however, exists, and one that Dr. Alland considers most important: In England, it was the English who changed their environment; in Vietnam, the United States is changing the environment.

"We are therefore largely responsible for the potential consequences," Dr. Alland concludes.

Dr. Alland uses plague only as a model for what can happen when a natural setting is disturbed. Such waterborne diseases as typhoid and cholera constitute a constant danger, as do various forms of dysentery and other intestinal diseases. Even malaria is sensitive to environmental changes that affect the breeding grounds of the mosquitoes spreading it.

Dr. Alland will conclude by stressing that the kind of "conventional" warfare of the past three years is, "in fact, intentionally or not, a kind of covert biological warfare," although he does not believe the U.S. has used or intends to use biological weapons as such.

The AAAS committee, appointed last December, will this year recommend its continuation as a commission "to facilitate the development of disciplined means of collecting information, planning, studying and controlling large-scale technological interventions into natural systems."

The committee recommends studies of the consequences of chemical use "in selected areas where massive programs are in progress." Besides Vietnam, "a region where the ecological effects may be expected to be most marked," the committee also suggests the northern Rocky Mountain region, where herbicides and pesticides are being applied on a large scale. ◈

HIGH ALTITUDE RESEARCH

I B P: Setting the Stage

From the Himalayas to the Andes to the Rocky Mountain town of Leadville, Colo., some 25 million persons live at high altitudes where the air has only two-thirds as much oxygen as at sea level. These individuals have thicker blood and larger hearts and lungs than their lowland counterparts. Their hearts beat faster, but the output is less, reducing their capacity for work. Their growth is retarded—Andean men average only five feet, one inch in height—their children reach adolescence later and, though it is a matter of controversy, some scientists think they are less fertile.

Spanish settlers in the Andean highlands were perhaps the first to record the effects of high altitudes on human physiology. Sixteenth century chronicles tell that for almost 50 years no child of pure Spanish blood was born to the men and women who migrated from Spain to the mountain town of Potosi, 14,000 feet above sea level. To preserve their race, these Spaniards moved their capital to the seacoast town of Lima, where they recovered normal fertility.

Scientific studies of the physiological effects of high altitude on highland natives and on lowlanders traveling or living more than 10,000 feet above sea level have only recently begun. Last week, under sponsorship of the World Health Organization and the U.S. International Biological Program, 60 scientists from 13 nations met in Washington to review what has been done and map plans for future research. Their work ranges from fundamental studies of the effects of environment on man to solutions to the practical health problems soldiers, athletes and travelers face if they move quickly from sea level to high altitudes. Of much immediate concern is the effect Mexico City's altitude—8,200 feet—will have on the health and performance of the hundreds of athletes who will fly there for the 1968 Olympics. Three or four weeks of training at similar altitudes is recommended.

According to Dr. Alberto Hurtado of Cayetano Heredia University, Lima, Peru, high altitude may contribute to the incidence of certain diseases. Lowlanders traveling rapidly to high altitudes are almost certain to get mountain sickness, characterized by severe headache, nausea and vomiting, fatigue, mental exhaustion, indifference to work and loss of appetite. Although recovery usually comes within a week, the effects on soldiers can be disastrous if they are moved into high altitudes and expected to fight immediately, says Dr. Frank Consolazio of Fitzsimons General Hospital, Denver. In studies of young American soldiers, he and his co-workers found high carbohydrate diets tend to reduce symptoms of mountain sickness. Carbohydrates increase carbon dioxide production which stimulates the respiratory system and raises oxygen content in the lungs in low-oxygen atmospheres. But the only real answer is to move troops from sea level to higher altitudes gradually during the course of a week or so to prevent the disease.

In spite of possible adverse effects of high altitude, natives of these mountainous regions adapt through natural acclimatization, though it takes hundreds of years for the process to complete itself. "In the Andes," Dr. Robert F. Grover of the University of Colorado says, "an Indian population has evolved which undoubtedly represents the most complete acclimatization to the environment of high altitude which man can achieve. Between the Andean native and the newcomer is the individual with an intermediate degree of adaptation. He is the man of European ancestry lacking any racial or genetic elements of acclimatization which the man of the Andes may inherit." In North America, Leadville—where people have lived for about 100 years—is the only home of these intermediate individuals.

Although scientists strongly suspect genetic factors play an important part in high altitude adaptation, their precise role is still to be investigated. However, evidence of genetic alterations at high altitudes comes from Dr. Elizabeth Carles-Trochain of the National Center for Science Research, Toulouse, France. When African natives migrate to high altitudes, she finds, they lose the blood factors that give them immunity to diseases such as malaria and sickle-cell anemia that are common in their native countries.

Studies of Bolivians, who practically all have type O blood, also suggest high altitudes may modify and standardize genetic factors which are much more variable in lowland populations. Dr. Carles-Trochain says. ◈

SATURN 5

Excellence Aloft; Exuberance in the Bunker

The Apollo 4 spacecraft returned to its Downey, Calif., birthplace last Wednesday after a leisurely, six-day journey aboard the aircraft carrier Bennington. Crewmen had fought high winds and rough seas for two and a half hours to haul the capsule from the Pacific, following a most unleisurely journey in which Apollo 4 traveled more than 11,000 miles into space and put the U.S. men-on-the-moon program back in orbit.

U.S. AHEAD IN MOON RACE! claimed the headlines and, indeed, U.S. space officials were exuberant. They had flown Apollo's mighty Saturn 5 rocket before the launch of any Soviet superbooster, such as the 10-million-pound-thrust monster (a third stronger than Saturn 5) whose existence has already been announced by U.S. space officials. But such an advantage is largely a paper one. Development flight schedules are so complicated—the U.S. must fly at least 10 more missions before trying for the moon—and the Soviet space program is held so close to the vest that winning individual battles tells little about who will win the war.

Furthermore, even if the U.S. leads in the brute force department, the Soviet Union may have an edge in maneuverability. The automatic docking, apparently on the first try, of Cosmos satellites 186 and 188 on Oct. 30 (SN: 11/11) could represent a test of a shortcut technique to enable a manned spacecraft of the Russian Soyuz type to join a second booster in orbit. Eliminating the need for carrying the crew and its equipment up from the ground on the main booster would greatly reduce weight and could save fuel for extended maneuvers or high speeds.

Still, this is largely speculation.

In the real context of the U.S. space program Apollo 4 was an unqualified success. Or rather a series of successes.

There had been several delays—the flight had been scheduled for launch almost a month before, and checkout difficulties had slowed things down so much that one 53-hour test lasted 18 days. But the final date had been set for almost a week, and it held despite problems with batteries, computers, fuel tanks and the fickle Florida wind.

The first cluster of firsts took place simultaneously at the launch, as the Saturn 5's 7.5 million pounds of first-stage thrust lifted the great white needle into the air. This was at once the heaviest object ever lifted off the earth, the first flight of the S-1C first-stage booster and the first flight of any Apollo hardware since some shoddy wiring caused a fire that killed three astronauts in their spacecraft during a ground test last Jan. 27 (SN: 2/4). The flight also marked the first operational use of America's moonport, Cape Kennedy's launch complex 39.

The fiery tail of the booster was visible until Saturn was almost 40 miles up, at which point the first stage ceased firing, blasted free and fell into the sea. The second stage, also on its maiden flight, fired for about six minutes, its total working life, and carried its payload to an altitude of 117 miles. There it in turn was jettisoned while the S-IVB third stage propelled itself and the spacecraft into a circular orbit less than two percent out of shape.

After coasting twice around the earth, the third stage scored one of the most important advances of the flight. Though it had flown three times in earlier tests, the S-IVB had never before had to restart its engine in space. This will be necessary on the manned lunar flight to push the Apollo spacecraft out of its parking orbit around the earth and onto a course for the moon.

The S-IVB restarted on cue. Up to the restart, the entire flight plan was an exact duplication of the one that will be used to send men to the moon. There it began to differ.

Had the spacecraft been pointing in a different direction, and had the S-IVB's engine burned 19 seconds longer, the unmanned Apollo capsule could have gone to the moon. Instead, its orbit was stretched so that it would reach more than 11,200 miles from earth, in order to provide enough speed coming back in to produce the terrible heat—more than 5,000 degrees F.—that will be encountered on the return from the moon. The spacecraft fully tested for the first time the Apollo heat shield, made of a phenolic material that uses up heat by boiling away.

During the two-and-a-half-hour trip to the distant apogee, the S-IVB was jettisoned. The spacecraft's guidance system kept the vehicle turned so that the thick side of the heat shield, which would bear the brunt of reentry heating, was constantly in shadow, so it could later absorb as much heat as possible.

On the way back from apogee, the spacecraft propulsion system fired a second time, kicking the reentry speed up to about 25,000 miles per hour, equal to that of a lunar return flight.

Reentry presented no problems. Two communications blackouts occurred as predicted, due to the ionized plasma sheath that formed around the spacecraft as it skipped through earth's upper atmosphere. Thanks to the new heat shield, the cabin apparently never got hot enough to become uncomfortable for any human occupants.

Now the command module—almost the only thing left from the 363-foot

NASA

Apollo emerges from Pacific.