3) Development of new methods for the characterization of polymers: light scattering, small-angle x-ray diffraction, polarized infrared absorption spectroscopy, rotatory dispersion measurement, nuclear magnetic resonance, differential thermal analysis, and sedimentation and diffusion in a density gradient cell.

4) Clarification of the mechanism of polymerization under various conditions: in solution, under conditions of suspension and emulsion, at high pressures, at high and low temperatures, and in natural polymers.

5) Enormous growth of the industrial uses and production of all polymers.

Predictions

The following important progress can be forecast, without too much risk, for the near future.

1) Lowering of the selling prices of all standard plastics and rubbers into the range between 20 and 30 cents per pound (44 to 66 cents per kilogram), with some priced as low as 15 cents. Lowering of the selling prices of most standard staple fibers into the range between 40 and 60 cents per pound, with some priced as low as 25 to 30 cents.

2) Synthesis of polymers which remain flexible and supple at temperatures as low as −100°C, and of others which can withstand temperatures of 500°C for long periods.

3) Development of adhesives which will make it possible to build houses, cars, and airplanes without nails, screws, or rivets.

4) Polymerization at low temperatures in the liquid or solid state, permitting rapid continuous production of many polymers of high purity, with convenient control of molecular weight.

5) Further improvement of the methods for characterizing polymers—in particular, nuclear magnetic resonance, flow birefringence, optical-activity analysis, and differential thermal analysis.

News and Comment

Lysenko: Attacks on His Theories Renewed in U.S.S.R. in Aftermath of Khrushchev's Removal from Power

The long scientific and ideological struggle involving the Soviet geneticist Trofim D. Lysenko is stirring again in the U.S.S.R., apparently as a consequence of Nikita Khrushchev's removal from power last month.

In the course of Khrushchev's 10-year reign, Lysenko lost the mantle of scientific infallibility that had been conferred upon him by Stalin, and a sort of scientific coexistence developed in the Soviet biological community.

In part, Lysenko's loss of power was probably related to Khrushchev's desire to loosen the ideological bonds on Soviet society; but it appears also to have been related to Khrushchev's determination to promote agricultural research as a means to greater food production. Given a choice between ideological purity and higher food output, Khrushchev seems to have sought a compromise between Lysenko and his opponents.

Lysenko, though no longer possessed of the dictatorial powers that he held under Stalin, held the directorship of the Institute of Genetics of the Soviet Academy of Sciences and served as editor of the journal *Agrobiology*. And his thesis, that heredity is governed by environment rather than by genetic material transmitted from one generation to the next, was frequently reflected in popular articles in the government and party press. At the same time, however, articles reflecting genetic theories held in the West were permitted publication, and it became clear that Soviet scientists were no longer risking their careers by publicly disagreeing with Lysenko.

Khrushchev's ouster as Premier and Party chairman now seems to have accelerated the downgrading of Lysenko. Writing on 2 November in *Pravda*, on the occasion of the 47th anniversary of the October Revolution, M. V. Keldysh, president of the Soviet Academy, included an oblique attack on Lysenko in the course of a lengthy review of Soviet science and technology. "With every year," the Soviet academician stated, "there is a wider development of research on the front line of biological science. . . . It must be said that the development of a number of sectors of modern biology has been impeded because of the dogmatic views of individual groups of scientists. The duty of scientists and agricultural and medical workers is to raise biological science to a high level and employ more broadly the newest achievements of biological science in the national economy and public health."

That was a delicate, though clear, reference to the Lysenko controversy. A few days later, however, according to the New York *Times*, a far less restrained attack was carried in *Pravda*, which not too long ago had served as a medium for Lysenkoist views. The Soviet newspaper noted that the latest issue of *Agrobiology* had disparaged prominent Soviet biologists who disagree with Lysenko by referring to them as "people who are lightheaded when it comes to theory" and as "biologists who try to ignore the [Marxist] dialectic."

Pravda added that, "while pouncing on classical biology and inadmissibly insulting different-minded geneticists, the journal [*Agrobiology*] at the same time constantly and in the most glowing tones talks about T. D. Lysenko." And *Pravda* went on to observe that it found this "all the more strange," since Lysenko is editor of *Agrobiology*.

According to the *Times*, anti-Lysenko views were also carried last week by other Soviet news organs. In a radio broadcast, Nikolai P. Dubinin, one of the scientists who was "insulted" by Lysenko's *Agrobiology*, stated that recent research has demonstrated that it is possible to control heredity through mutations induced by

radiation or chemical means. Dubinin lost his research post in 1948 when Lysenko was working under the aegis of Stalin. He was reinstated during Khrushchev's leadership. And, writing in *Izvestia*, S. Alikhanyan, a biologist with the Institute of Atomic Energy, stressed the use of radiation as a means of producing mutations. "Unfortunately," he stated, "the introduction of these methods into plant-breeding practices as well as the development of the appropriate branches of genetics and selection work have been held back by the dogmatic views of some scholars." No public rebuttals from either Lysenko or his followers have appeared.

The ups and downs of Lysenko and his associates over the past 15 years should induce humility in any speculation on just what the renewed flaring of the controversy may mean for the future of Soviet science. Since Khrushchev disappeared from power in the wink of an eye, it would seem to be a relatively simple matter to apply the same procedure to Lysenko. But since he undoubtedly has many followers in the Soviet scientific community, and since the Soviet leadership seems to be paying increasing court to intellectual freedom, it is quite possible that the political leadership will let the scientists slug it out in the professional and popular journals without imposing a solution from above.

Keldysh's *Pravda* review of Soviet science and technology was quite restrained on the matter of Lysenko, and carried no suggestion that his presence in the Soviet scientific leadership is intolerable. What was perhaps most striking about Keldysh's article was that it sounded very much like many of the papers that American scientific leaders have drawn up at the invitation of the various congressional committees that have been studying federal support of science. In fact, if the homage to communism and to the wisdom of the Communist Party were removed it might pass unnoticed as a typical plea for ample government support of science and technology. For example: "The high level of theoretical science is one of the basic prerequisites for the successful advancement toward Communism. This is why it is necessary to spend a great deal of time for its development, continuously raising the level of scientific research. . . . The means spent on [the development of computer technology] will be repaid a hundred-fold. The highly qualified cadres and the mighty material basis of scientific research are the necessary conditions to our achieving a leading position in the scientific world. . . ."

Perhaps the most significant departure from prevalent American thinking was in regard to the relationship between basic research and industrial technology. On this subject, a good number of leaders of the American scientific community feel that closer ties should be developed between basic science and industry. But it is probably safe to say that the majority are either indifferent to the problem or distinctly opposed to orienting basic research toward industrial goals. Keldysh, however, urges that basic research must not be permitted to exist as an entity remote from Soviet economic needs. Basic research, he stated, must be increased, but "it is necessary to pay serious attention . . . [to the] rapid use of results in the national economy. The scientist must not only develop the theory, but he must understand in time the meaning of the discovery, bring it . . . to life, which is important for the development of the national economy. This can only be attained with a close contact between the Academy of Sciences of the USSR, and the higher institutions of learning, along with the Government's industrial committee, having constant contacts between theoretical science, the specialized institutes, and industry. . . . It is highly important to organize theoretical research in such a way that industry would receive the resulting data of science necessary for the creation of new technological processes."

It would seem from all this that the Soviet Academy President may have more important things on his mind than the ancient Lysenko affair.

—D. S. GREENBERG

Space: National Academy Panel Recommends Exploration of Mars as Major Goal in 1971–85 Period

Since the spring of 1961, when a manned landing on the moon by 1970 became a certified national goal, the United States space program has been essentially a buildup to the lunar landing. In the past year, however, space planners have begun to look seriously beyond the moon, and on Tuesday the National Academy of Sciences released a statement of its space science board, on "National Goals in Space, 1971–1985."

In this statement the board designates "exploration of the nearer planets as the most rewarding goal on which to focus national attention for the ten to fifteen years following the lunar landing." Mars is put at the top of the list as the "primary goal," with exploration to be carried out initially by unmanned vehicles and a hope held out for manned exploration by 1985.

The recommendations in the report are not startling. They are quite general and have been foreshadowed in informal statements from National Aeronautics and Space Administration officials and from non-NASA space scientists. Space-program planning is influenced not only by scientific priorities, however, but also by questions of national prestige and national security and by consideration of the very large sums of money involved, and the space science board's statement must be viewed in this larger context.

In its relations with Congress and the public, NASA and the administration are aware of a danger of anticlimax. While it is certainly not all NASA's fault, the lunar landing program has been represented as a kind of space Olympics test against the Russians and a *sine qua non* of national security. If the public does, in fact, regard a successful manned round trip to the moon as a kind of conquest of Everest in space, there may be less public support and enthusiasm and less support for more difficult and more expensive tasks afterward.

A shift of major emphasis to the exploration of Mars is likely to further offend those who feel that the military implications of the space program have not received sufficient attention. A "bomb in orbit" is perhaps the best-known threat cited by those who think that much more attention should be paid to increasing the capacity of the U.S. to operate in space between earth and the moon.

An "on to Mars" policy would also be likely to arouse displeasure among those scientists who think that the dazzling technological advances being made in the moon program should be exploited for the sake of science by a greatly stepped-up program of investigations on and around the moon through both manned and unmanned flights.

The board, in fact, has suggested "alternative goals" for the 1971–1985 period, explaining that "extensive manned lunar exploration—including base construction and major manned orbiting space station and laboratory programs—have sufficient merit to war-