In sum, we find that plants infected with TMV also produce small but consistent amounts of an auxiliary nucleoprotein, I8. Although apparently possessing biological properties identical with those of TMV, I8 is different from the latter with respect to chemical composition and certain physical properties. Both proteins are rods of similar size and shape, contain about the same amount of nucleic acid, show certain similarities in amino acid composition, and are close immunochemical relatives.

Several possible explanations of these observations need to be considered (*8*):

1) *That I8 is a strain of TMV different from the common form used as inoculum.* This proposal would imply either that I8 was present as a contaminant in the original inoculum, or that it originated by mutation in the infected leaf. However, the biological properties of TMV and I8 appear to be identical. Furthermore, no TMV-related virus strain is known that is not initially soluble in buffer. It is unlikely, therefore, that I8 represents a virus strain different from the common TMV used as inoculum.

2) *That I8 represents an intermediate or alternative product of the specific biosynthesis of ordinary TMV.* This proposal coincides most closely with the information on hand at present. The two proteins are equally characteristic products of plants infected with TMV. They appear to be biologically identical and are very similar in composition. These facts indicate that I8 and TMV are common products of the specific biosynthetic processes induced in the host by the entering TMV inoculum.

The distinct differences that we find in the composition and physical properties of I8 and TMV lead to the further conclusion that the biological specificity of the virus is not rigidly dependent on the particular chemical structure ascribed to ordinary TMV. This conclusion is subject to two alternative interpretations: (i) In the reduplication of the virus, a certain range of latitude in the chemical composition of the product is tolerated without discernible alterations in biological specificity. In this view, I8 would represent one of the allowed alternative structures of the virus, its distinguishing physical properties and cellular location being a consequence of slight, biologically inconsequential chemical differences from ordinary TMV. (ii) Alternatively, the foregoing results may be construed as evidence that the biological specificity of the virus is determined by only part of the chemical structure of ordinary TMV, and that this determinative subunit is present in both I8 and TMV.

Within either interpretation, consideration must also be given to the possibility that I8 is the initial form in which the virus is synthesized, being subsequently converted to the soluble TMV commonly found in the infected plant. Further investigations of these relationships should help to illuminate the biochemistry of TMV reduplication.

References and Notes

1. B. Commoner *et al.*, *Science* **118**, 529 (1953).
2. Aided by a grant from the National Foundation for Infantile Paralysis. We are Grateful to Kathryn Baker and Betty Read for assistance in carrying out some of this work.
3. H. G. Kunkel and R. J. Slater, *Proc. Soc. Exptl. Biol. Med.* **80**, 42 (1952).
4. G. L. Miller and R. H. Golder, *Arch. Biochem* **29**, 420 (1950).
5. F. G. Fischer and H. Dörfel, *Biochem. Z.* **324**, 544 (1953).
6. G. R. Wyatt, *J. Gen. Physiol.* **36**, 201 (1950).
7. M. Heidelberger and F. E. Kendall, *J. Exptl. Med.* **62**, 697 (1935).
8. Bawden [F. C. Bawden and N. W. Pirie, *Brit. J. Exptl. Pathol.* **26**, 294 (1945)] has reported that when TMV is removed from infected leaf by expression of sap from minced tissue, a considerable amount of infectious material remains in the residue from which it can be released by enzymatic treatment or milling. This residual virus does not appear to differ from the initially extracted virus with respect to physical and chemical properties; it represents about one-third of the total TMV content; we find that it can be extracted by buffer from homogenized leaf. In all these respects Bawden's residual virus differs from I8; the two components are therefore not identical.

The "Atomic" Rivals

Francis Simon*

Clarendon Laboratory, University of Oxford, England

DEVELOPMENTS in the domain of atomic energy are going to affect our future profoundly. Already it is clear that all our ideas about defense and the role of conventional weapons will soon have to undergo a radical change. (Even though the general public does not yet seem to have realized all the implications of the latest development, the "cheap" hydrogen bomb.)

* Reprinted by permission from the *Financial Times* (London), 6 Aug. 1954, with the thought that our readers may be interested in seeing how the position looks from the other side of the Atlantic. Sir Francis is professor of thermodynamics at Oxford.

The development of atomic power for industry is a comparatively long-term project, but its consequences will be almost as far-reaching as in the weapons field. Probably the first really important changes will be seen in those underdeveloped countries where a relatively small-scale provision of power would make a great difference. Nuclear fuels will not have such a marked impact on the more highly industrialized countries which now depend on coal and oil for their power, if only because of the much longer time needed to change over their enormous power systems to nuclear energy. As I have discussed elsewhere [in a contribution to *Atomic Energy, A Survey* (Taylor and Francis, London, 1954)], a really large-scale takeover from the conventional fuels can hardly occur before the end of this century, and it will probably be the middle of next century before we can rely mainly on nuclear fuels. However, such an extended time-scale should not blind us to the fact that this country has to make a big effort very soon in order to avoid being left in the cold by the eventual exhaustion of our ordinary fuels. Moreover, the export of nuclear power stations to the underdeveloped countries offers Britain possibilities of the greatest economic importance.

Under these circumstances, it is natural to ask what countries have most chance of success in the field of nuclear energy. First of all, since the expenditure connected with atomic development has to be counted in thousands of millions of pounds, only countries that have a very high technologic and scientific potential can compete. This at present limits the field to the United States and the U.S.S.R., on a smaller scale Britain, and later on perhaps Germany. Smaller countries can hardly hope to compete successfully, at least at the moment, even though the quality of their scientists and engineers may be just as high (if not sometimes higher) than in the countries just mentioned. Of course, if fissile material were made available to these smaller countries as is envisaged by the Eisenhower Plan, they also may come into the picture. For today's discussion, however, it is sufficient to regard the United States, the Soviet Union, and Great Britain as the countries chiefly concerned.

Success will depend mainly on the way in which the natural assets of each country are utilized, and the most important of these assets is the country's scientific and technologic manpower. Let us first compare the West with the Russians. The Russians have always had some excellent scientists, but in the past the West has had many more of them. Although this inferiority in numbers is no longer so marked, many people, including myself, had hoped that Russia, as a result of enforcing an ideological strait jacket on her scientists, would never become a serious competitor. This hope seems to have been a false one. As far as one can judge, Russian scientists—at least in most subjects of direct practical importance—seem able to get away with lip service to the Communist ideology and can do more or less as they want to. Certainly a lot of excellent work is now being published by Russian scientists.

But are they not very far behind in their technology? It is difficult to see why this popular belief can still remain so widespread after everything we know about the quantity and quality of their artillery, ammunition, tanks, and aircraft during the war—all produced under most difficult conditions. The real position with respect to scientific and technologic manpower does not seem to be realized in the West. The output of science and technology graduates in the U.S.A. has been falling more or less continually from 1950 onward, while in the U.S.S.R. it is going up all the time; the indications are that the Soviet's annual output is now twice that of the U.S.A.! In addition, we can be sure that the Russians are concentrating a higher percentage of their effort on essential projects, such as atomic energy, than can be done in the West where no government dare starve its people of consumer goods.

Thus, there is a *very real danger* that the Russians are going to overtake us in the atomic field by putting a bigger effort into it. Perhaps the most serious aspect of the spy hunt in the U.S.A. is that it misleads the public into believing that the Russians can progress only by stealing "secrets." The supreme error in war, hot or cold, is to underestimate one's adversary. Indeed it is difficult to imagine anybody doing more to help the Russians than those people who, for whatever purpose, create an atmosphere of spy hysteria.

This question of espionage is now so much in the public mind that we must discuss it in some more detail. In view of the enormous power of the atomic bomb, it is obvious that at first all atomic energy work had to be fenced in by security regulations, just as any important military operation is. For instance, the very fact that work was being done on nuclear fission was an important secret in the war against Germany. Now, not only has the adversary changed, but the whole position as well.

The physics of the release of nuclear energy for either war or peaceful purposes is now almost universal knowledge. The really important information is the technical know-how. In most modern industrial processes this know-how is a complex sum of technical and scientific knowledge and art which cannot be described even in the most lengthy patent description. (Indeed the last decades have seen a decline in the importance of the patent for just this reason.) In order to sell the know-how of a technical process from one firm to another, it is now quite common for teams of highly skilled people to be sent off for years to the purchaser in order to give him the benefit of the new development. To suggest that such knowledge could be acquired and handed over to an enemy by one or two persons, whispering a few words over the lunch table or by stealing some "secret formula," is simply not realistic.

Now let us assume for the sake of argument that some important information is handed over to a potential enemy. How much benefit could he obtain from it? One could tell almost anything to technically underdeveloped countries and it would not help them one iota, simply because they have not the necessary scientific and technologic resources to make use of it. Only a country that is at practically the same technologic level as that from which the information originates could derive any material benefit. However, such a country is just as likely to make new developments under its own steam as to have to rely on outside sources. Whether we like it or not, we have to realize that, although the Russians started somewhat later than the West and although they very probably still have fewer weapons than we do, they are now equal to us in their knowledge of the techniques of "atomic" war and peace. The "secret" of the latest hydrogen bomb, the "cheap" one, was certainly not stolen from the United States—it was actually developed earlier by the Russians!

What is responsible for the remarkable preoccupation of the U.S.A. with spying? Part of the explanation may be the curious ideas held by the general public about the nature of scientific progress and about the way scientists work. Indeed many people say, "Well, the danger is perhaps overrated, but what does it matter, one can never be *too* safe." They ignore the most important point. Scientific and technologic progress does not come about as the films would have us believe: a man sits in his study or fiddles at some weird looking instrument and suddenly the great inspiration comes, and that is all. Ideas are, of course, an essential part of every new advance, but ideas develop much better in an atmosphere of close contact with one's colleagues. Criticism, friendly or even unfriendly, plays an essential role. Without an exchange of ideas and the ensuing cross-fertilization, developments are intolerably retarded. To try to achieve 100-percent "security" by locking every person up in his little cell, would result in 90-percent sterility. One must therefore strike a balance between making the exchange of information and ideas as free as possible (in order to accelerate the development) and preventing certain important *and* easily transmittable information (which of course still exists, as for example, the size of the effort) from reaching the enemy.

It is very probable that the Russians were helped in the beginning by information obtained from spies, and nobody advocates carelessness over atomic matters. (In particular, sabotage may play a very important role in or just before a future war.) We have, however, to realize that Russia's main strength in the nuclear field is now her own excellence in science and technology and the magnitude of her effort. Security regulations are necessary, but they should be handled with a minimum of interference with the normal practice of science and technology; otherwise we do enormous harm to our own effort.

How far the Americans have deviated from a sane compromise is evident if we have a look at what is happening at the present moment in their country. Here I only want to mention one case that is of particular interest to us. Some months ago a visa was refused to the theoretical physicist, Dirac, one of the most famous and highly respected members of the scientific community, not only of Britain, but of the world. This refusal was made under the terms of the section of the Immigration and Naturalization Act which, to quote the American journal *Physics Today*, "covers categories of undesirables ranging from vagrants to stowaways." In a letter of protest to the press, some leading American physicists said:

> If this is what the McCarran Act means in practice, it seems to us a form of organized cultural suicide. We are very strongly aware of the advantages to this country of Professor Dirac's proposed visit. We are aware of no disadvantage. We also know that his case is only a particularly obvious example of a general policy which operates to this country's detriment.

The picture is a very depressing one. We see the West faced with a rising flood of Communist expansion. However, instead of doing everything to insure technologic superiority, the Americans are busy at places where the danger is largely imaginary, and in doing so immobilize and antagonize the scientists, the very people who are essential for our defense.

I now want to say a few words about the *peaceful aspects of atomic power*. It is true that these problems have not the same degree of urgency as the military applications, but—if we survive the next decades—they will eventually be of paramount importance. Here again progress will be determined largely by the availability of scientists and technologists and by how we make use of them.

At the moment all three countries seem to have reached about the same stage. A medium-size nuclear power station is reported to have started operation in Russia, while quite sizable stations can be expected to operate in Britain and the States within 2 or 3 years. In the future much will depend upon the way information is put at the disposal of industry. Very little is known as to how the Russians handle this problem. The United States is now preparing a law that will make information, as well as fissile material, available to her own industry. This is certainly a step in the right direction, and we can expect a vigorous development.

In Britain there is every hope that the new Atomic Energy Corporation is going to take industry into its confidence. Unfortunately, there does not seem to be much hope of the really close collaboration between this country and America which is long overdue. Had the United States not broken off the wartime collaboration with Britain about 10 years ago—again on account of a mistaken idea of "security"—it is very likely that both countries would now be much further on. As it is, both have to rely on their own efforts. What are the chances for us?

Britain has without doubt sufficient scientific and technologic potentialities to compete in the atomic power markets; the achievements of our atomic energy project with its relatively restricted means are certainly admirable. However, large-scale developments will need very much more technologic and scientific manpower than we have now, and no serious steps are yet being taken to remedy our shortcomings. I do not have the space to go into details, but I would like to refer the reader to my article on "The shortage of scientific manpower" which appeared in *The Financial Times* survey of British industry, 1954.

Why is so little being done in this all-important matter? It is said that the sums needed to modernize our technologic education and to create a healthy stock of science teachers cannot be made available. This, of course, is simply not true. Although it is often professed by V.I.P.'s in after-dinner speeches that in the world of today the future depends on science, one has only to have a look at the way the country's money is spent to realize that this is mere lip service. Nobody can really uphold that a cut of, say, 1 percent in our defense expenditure would be of any great consequence—while these £15m per year would *double* the sums available to science and technology in the universities and the Department of Scientific and Industrial Research. Such a switch would increase our defense potential, as well as our chances for industrial survival, infinitely more than the damage due to the small reduction in the number of conventional weapons, which anyway will most probably be obsolete before they are ready.

These figures show clearly that the fact that this country must depend on its scientific and technologic manpower has not yet sunk in. This may be because the general public—certainly in this country—is not really science-minded. How often do we see people snobbishly dismissing all scientists and engineers as "narrow specialists," even though they themselves do not know the difference between science and gadgeteering. They do not realize that it is *their* narrow outlook which is an essential cause of our deficiences.

To sum up: It seems that the West has not yet learned to think in terms of the real values of this scientific age. The most important of these realities is the quality and quantity of scientific and technologic manpower. The Americans seem to be too blinded by their preoccupation with spy hunting to see that they are doing incalculable harm to their own scientists and that they are in grave danger of being overtaken by the Russians by quite legitimate means.

We in this country are fortunately free from the spy hysteria, but our share in the weapons project is anyway no more than that of a junior partner. On the other hand, the peaceful applications of atomic energy are bound to become essential for our future and here again the scientific manpower question is paramount. The facts are there for everyone who wants to see, but a deep paralysis seems to prevent us from doing what is necessary.

We are used to hearing Western papers loudly expressing contempt of the Communist countries, but this is neither sufficient nor even essential. We must *do better* than they, otherwise future historians may well be tempted to pass the famous verdict also on our generation: "Deus quos vult perdere, dementat prius."

News and Notes

International Weights and Measures, 1954

Continuing a series begun in 1889, the Tenth General Conference on Weights and Measures was held in Paris and Sèvres, France, 5 to 14 Oct. Of the 35 countries that belong to the international organization, 32 appointed delegates or observers, the total number being more than 70. As representatives of the United States, the Department of State appointed Allen V. Astin, director of the National Bureau of Standards, and E. C. Crittenden, consultant to the NBS.

These general conferences, which are convened at 6-yr intervals, exercise general authority over a permanent international committee of 18 members, which meets biennially. The committee is responsible for directing all projects in metrology that the member-countries decide to undertake jointly, including the preservation of the international metric standards and other activities of the International Bureau of Weights and Measures. The Bureau is housed at Sèvres in the Pavillon de Breteuil, an ancient residence designated as international territory. The International Bureau has a staff of about 16 persons. Besides providing a depository for international standards, it carries on important researches on many metrological problems, calibrates standards for other laboratories, both national and privately owned, and serves as a permanent secretariat for the international committee and the General Conferences on Weights and Measures.

Problems of measurement have become so diverse that no single small group of men can deal with them. Consequently to assist the International Committee on Weights and Measures in special fields, four advisory committees have been set up, each consisting of representatives of seven or eight national laboratories and some experts selected individually from smaller countries. The present advisory committees cover measurements and standards in electricity, in photometry, and in thermometry and the project for a new definition of the meter.

Many countries that belong to the international weights and measures organization do not have representatives in the permanent committees. Consequently one of the purposes served by each general conference is to inform member-countries of the progress made during the preceding 6-yr interval. The conferences are called upon to make decisions only on matters of principle or on changes of policy or practice.

Current work of the International Bureau was reported to the conference by Charles Volet, director of that Bureau, and various members of the Bureau's staff. It included comparisons of electric and photometric standards from all the larger countries, showing a very satisfactory degree of uniformity in the new electric units as adopted in 1948 and good progress toward uniformity of photometric measurements on all types of lamps. Comparisons of end-gages calibrated at various national laboratories by means of light-waves indicated that such calibrations are now sufficiently precise to meet the ordinary needs of in-