Science Knows No Boundaries

Wilder Penfield

"This Association in meeting in Canada has assumed a continental and international character." Those were the words of the president-elect, Sir William Dawson, geologist and principal of McGill College, when the AAAS last met in Montreal. He made you welcome here 82 years ago, and tonight it is my privilege and the privilege of Paul Dugal to welcome you again, this time in French as well as in English.

The American Association for the Advancement of Science has made good the promise of the name it took. It *has* advanced science. It *is* American in the broad continental meaning of that word which includes us all, above and below the border. More than that, it *is* international in scope and influence.

I say this from the vantage point of medicine, the Mother of the Sciences. But tonight I speak for scientists of every discipline across this vast country, from the universities of British Columbia and Victoria to Dalhousie in Halifax. We welcome you now with pride as you come again to Canada and to Montreal. This is not the Montreal your predecessors knew, with its ice palaces and its snowy streets merry with the sound of sleigh bells and the shouts of fur-coated, fur-hatted Canadians.

If you have read the recent press releases, you who come from the United States must have thought that something strange is going on in Canada today. But do not be misled. We are not disintegrating nor drifting into civil war. In every province there is a solid Canadian majority made up of sane, realistic people. Perhaps I may claim to see it clearly. I was once a stout American. Now, I am a loyal Canadian who has joined the English-speaking minority of Quebec. But in spirit I am an equally enthusiastic member of Quebec's French majority.

The United States came to independent nationhood all at once during the agony of war—11 years of it. Canada never knew rebellion, never tore out the antecedent roots that gave her strength from the past. Just a hundred years ago, a Confederation of the Provinces was planned in Charlottetown. The confederation would accept protection from the British Crown without taxation. Complete independence has come since then.

Canadians resemble Americans, but they are different—more conservative and very stubborn. They are closer to the culture of Europe. Deep down in them there are strong but varied allegiances. Two compelling reasons explain why Canada has never sought to join the United States: the "British Fact" and the "French Fact"—loyalty to the British Crown and to a tradition which is both Scottish and English on the one hand, and, on the other, loyalty, not to France but to the French language and to French-Canadian culture and French-Canadian Catholicism. We have set out to prove that in alliance there is strength and great resource.

There is a quiet revolution going on in the Province of Quebec, a fundamental change in the structure and organization of education, particularly French-language education. It will mean economic advancement to French-Canadians. No doubt of that. But the revolution is not against the rest of Canada. It is within the French-speaking people, and initiated entirely by themselves. It is assisted by a wisely liberal change in policy within our Catholic Church. It has been organized by the most efficient and far-seeing Provincial Government within the memory of Quebec citizens.

The old French University of Laval, in Quebec City, and the 43-year old, French-speaking University of Montreal are today modern liberal institutions that rank with the world's best. L'Université de Montréal, on the other side of the Montreal mountain, has had a phenomenal rise with an enrollment well above 8000, and almost as many again in polytechnic and commerce courses. There are many thousands more who take part in French TV and radio courses through the 24 outlet stations of French-speaking Radio Canada.

There is a close bond of sympathy and understanding between this university and the two English-speaking institutions on this side of the Mountain —Sir George Williams University and McGill University.

Two cultures and two current languages are sources of great strength to Canada, a truth which radical minorities on both sides still fail to recognize. They talk (sometimes in anger) of retreat and of a narrow retrograde nationalism. This, I am confident, will pass.

It is not so long ago that Wendell Willkie, an American of great stature, returned from a journey around the world, talking wisely of "One World." Today the problem of second-language learning is one that educators in every forward-looking nation know they have to solve. And science has something to teach these educators.

Canada could be bilingual in fact as well as in name. The child who has heard second languages well spoken before the age of 6 or 8 has conditioned his brain. He has taken over areas of uncommitted cortex that will otherwise not be available in later life. In the years that follow he will have a better brain for filling out vocabularies and also for adding other languages. There is evidence, too, that he will have a better brain for nonverbal skills.

One of the primary objectives of the quiet revolution in Quebec is to purify the French that is spoken here. But, to purify the use of the mother tongue, it is neither necessary nor advisable to shut the little child away from hearing a second language early.

French Canada has a vast pool of potential native French-speaking teachers in its population of six million. This is strength at hand for educators in English Canada. That same pool of teachers could be available to the demands of the primary schools of the United States. It is good French.

Science knows no boundaries, and science it is that must teach the nations by precept and by example how

This is the welcoming address delivered by Dr. Penfield, honorary chairman of the AAAS Montreal meeting, on 28 December 1964. Dr. Penfield is honorary consultant at the Montreal Neurological Hospital.

to live together and to cooperate and to communicate. Scientists are themselves sometimes excellent ambassadors.

Eighty-two years ago when this Association met here in Montreal, young William Osler was professor of the Institutes of Medicine at McGill. He reported his early work on blood in three short papers. No one, in his generation, did more than he to draw three great nations together—Canada, United States, and Britain.

Like Osler, the physicist Ernest Rutherford moved through the English-speaking world. He received his early education in New Zealand; began his research on the atom at McGill University; and then sailed away to carry on his epoch-making investigations at Manchester and Cambridge Universities. His disciple, Peter Kapitza, today works in the Soviet Academy of Sciences. Kapitza is director of the Moscow Institute of Problems of Physics, Academy of Sciences, U.S.S.R. Lev Landau and others interested in the properties of substances at low temperature work under his direction.

You and I and all men of science, except the few involved in defense research, are communicating constantly with scientists in every land. The flow to mainland China is voluminous. They will soon be reciprocating. Pray God the peoples of this world will learn, before it is too late, to be friends and exchange information and thought on every level of society. Only thus will all men come to know and understand their counterparts, their opposite numbers, on every side of every barrier and boundary. When that day dawns, peace will be secure.

Reports of Symposiums

Hydrogen Bonding

Hydrogen bonds are as common in nature as ordinary chemical bonds, and it may be stated with but slight exaggeration that they are equally important. They hold together the molecules in ice and in liquid water. They often provide the greater part of the forces that act on molecules dissolved in a solvent. They are present in electrolytes and in many crystals and rocks. There are billions of them in every living organism including our own bodies, and they are most important for the basic mechanisms of life. Thousands of research papers have been devoted to hydrogen bonding.

A well-remembered symposium on problems related to hydrogen bonding took place in 1957 in Ljubljana, Yugoslavia. The aim of another one-day symposium, part of the annual congress of the American Association for the Advancement of Science (Montreal, 29 December 1964), was to point up new developments in the field since 1957.

A review concerning wave-mechanical treatments of hydrogen-bonded systems was presented by S. Bratoz (Centre de Mécanique Ondulatoire Appliquée, Paris). The most reliable detailed calculations made recently are related to the $(FHF)^-$ system. The hydrogen bond holding this ion together is the strongest known hydrogen bond; it is of fundamental importance because of the relative simplicity of the system. There are "only" 20 electrons in this ion and it is now possible to include all of them explicitly in the calculations. Such "exact" calculations were made (among others) by Clementi and MacLean and by Bessis and Bratoz. The former computed the total energy of the ion with good accuracy; the latter, its dissociation energy in fair agreement with experiment. They have shown also that only the ground state is stable; it is characterized by diminution of the electronic charge density around the proton as a consequence of the formation of the hydrogen bond and by a corresponding increase around the fluorine atoms. In the first excited state, the electronic charge would increase around the proton, a fact connected with the instability of this state. Bratoz pointed out that such exact calculations are now possible for somewhat more complex systems.

For rough purposes, fragmentation of the hydrogen-bond energy into electrostatic, delocalization, repulsive, and dispersion contributions seems still to be admissible, although, as Bratoz has shown, the importance of the electron migration which is consecutive to the hydrogen-bond formation should be stressed much more. There is a similarity between hydrogen-bond forces and charge-transfer forces which offers a useful new way of looking at hydrogen-bonded systems.

Much of our knowledge of hydrogen bonding is based on spectroscopic and other measurements on solids or liquids in which we actually observe cooperative effects between many hydrogen bonds or one hydrogen bond perturbed by strong environmental effects. Therefore study of hydrogen bonding in the gas phase is of fundamental importance if we require knowledge of just one hydrogen bond; such work was reported by H. J. Bernstein (National Research Council, Canada).

Bernstein and his collaborators measured the infrared spectra of systems like methanol + triethylamine which, under adequate circumstances, remain hydrogen bonded in the gas phase. They used the results of their measurements at various temperatures and pressures for determining the energy (enthalpy) of the hydrogen bond ΔH. Using thermochemical cycles, Bernstein derived relations between ΔH and $\Delta\nu$, the difference of the X—H stretching frequency of the free and associated species. These relations involve the dissociation energy of the H—A radical (A being the proton acceptor) which can be computed from the data. An interesting result is that species like the neutral NH_4 radical are predicted to be stable.

Another remarkable result of Bernstein's gas phase studies is that although $\Delta\nu$ in the gas is essentially the same as in the condensed phases the bandwidth is much less.

There was animated discussion of possible explanations of the breadth