Thinking about the botanical sciences in Latin America, the clearest statement and the most important statement that can be made is you, what you are doing, what you do every day, and what you do in coming together here in this beautiful center in Mexico City to celebrate the solidarity of your effort, and, if I may say, our effort, from throughout this enormously wonderful and diverse region for biodiversity.

The many disciplines represented at this Congress in Systematics, Mycology, Morphology, Physiology, Ethnobotany, Coevolutionary studies, Ecology and Environmental studies on a large and small scale, folk taxonomy, and many approaches that you are taking, and the development of these approaches in all of the diverse countries of the region, give ample testimony to the ongoing development of the botanical sciences, sciences that, as Minister Julia Carabias has just stressed in her remarks, and as I will stress in mine, are completely indispensable to the future of the region. The botanical diversity of Latin America exceeds the diversity, by far, of any other region on Earth. I might begin talking about it by reading a quotation from Gonzalo Fernández de Oviedo y Valdés, 1526, about the diversity that he found here. This, as you may know, was a comment on the botanical diversity of Latin America that Paul Allen published in his Rain Forest of the Golfo Dulce, but I think it still speaks to the wonder and the beauty as well as anything I know. Oviedo wrote:

"I say, in general, that the trees of these Indies are a thing that cannot be explained, for their multitude; and the earth is so covered with them in many parts, and with so many differences and dissimilarities between them, both in their great size as well as in the trunk and branches and bark and in the aspect of their fruits and flowers, that not even the native Indians know them nor know how to give names to the majority, and the Christians much less, since they are so new, and not known or seen by them before. And in many parts one cannot see the sky from below these woodlands (for their being so tall, and thick, and full of branches) and in many places one cannot walk between them; because, besides their thickness, there are other plants and herbs so interwoven and twined about them and mixed with so many thorns and vines and other branches that it is only with much effort and by force of knives and axes that it is possible to open a path. And in this respect one could say that this is a Great and Dark Sea; because though part is seen, much more is not, since their names and properties are unknown, as I have said. There are some of them of good odor and beauty of flower and with fragrant wood or bark; others of innumerable and diverse forms of wild fruits that only the little catlike monkeys understand and know which are to their purpose. Other trees are so spiny and armed that they cannot be touched with the naked hand; others are of evil and savage appearance; others loaded with ivy and vines and similar things; others completely filled from top to bottom with a sort of thread, so that they appear covered with woolen yarn, without its being so. Some have fruit and others have flowers and still others burst into growth and yet each kind enjoys the season in its own way and one may see every stage of development at a given time and during any part of the year."

Those comments, which were made nearly 500 years ago, still express the wonder and the astonishment that we, who are concerned with the region, and everyone who is concerned with the world’s biodiversity, feel that this Great and Dark Sea is composed of the richest assortment of plants and other biodiversity found in any part of the Earth.
Latin American plants used to be estimated at 80,000 to 90,000 species, but I would say a better figure now may be 100,000 to 110,000 species. In a recent presentation at the Missouri Botanical Garden in St. Louis, Iain France estimated that worldwide botanical diversity, instead of being about 250,000 species, which is the traditional number, is probably more like 300,000 to 320,000 species based on the fact, among other things, that approximately 12,000 species a year are listed in the Kew Index. With 12,000 species described every year for over 10 years and no real sign of slowing down, and cryptic and unusual species being found as part of the mix in all collections and all careful studies of tropical floras particularly, it is more likely that the total number of plants of the world will amount to approximately 300,000 to 320,000 species, of which then approximately one-sixth still remain to be discovered. In Latin America, that probably means that 20,000 to 25,000 species of plants are either unknown, uncatalogued, unregistered, or unnamed; and that they may or may not be represented in herbaria at the present time.

There is an enormous amount of work to do. It is wonderful that botanists of this region, and beyond, are recognizing this work by the ample production, not only of local floras like the floras of Oaxaca, of Chiapas, flora Nova Galicia, and so forth, but the flora of Mexico itself and floras of Costa Rica, Nicaragua, Venezuelan Guayana, Chile, and Argentina, among others. Also in databases for Bolivia, Ecuador, and Venezuela that are underway. And, of course, Flora Mesoamericana, a larger regional effort in which we are partners with Universidad Nacional Autónoma de Mexico and with many regional botanists, and Flora Neotropica, the standard for the region.

The kind of diversity represented by these plants, and the kind of diversity represented overall by the plants, animals, fungi, and the organisms of Latin America, serves human beings in innumerable ways. In fact, we should always remember that it is the living systems of this planet, the aggregation of organisms, the millions of species of organisms—probably 5 to 10 million kinds of eukaryotic organisms (of which fewer than one quarter have been named)—are relatively well known. It is these living systems, the kinds of species, the relationships between the species, and the genetic diversity of the individual species that makes the planet Earth, which we share with one another, what it is. The characteristics of our Earth, of its atmosphere, have been changed by the activities of living organisms over billions of years to an oxidizing atmosphere from its original reducing state. The characteristics of the soils, of the waters and everything about the Earth, its productivity, its ability to transform a small fraction of the energy from the sun that bombards the Earth into chemical bonds in the roughly 300,000 species of photosynthetic organisms, that along with the fungi, are our main focus of attention at these meetings, and those properties are what make the Earth what it is, and what makes the Earth a place where we can live and characterize it as a place into which we have evolved.

Although tens of thousands of kinds of plants have been used by people for food at one time or another, and thousands are being used by people for food at the present day, just over 100 species of plants provide over 90 percent of all of the calories that we consume. Among them, maize, wheat, and rice provide directly or indirectly over 60 percent of all those calories. Our dependance on organisms for food and our dependance, therefore, on our ability to be able to harvest this food, to be able to grow it agriculturally in sustainable systems, is well known. In addition, the dependance of human beings on plants as a source of medicine is an important further consideration.

In Latin America, as throughout most of the world, plants provide directly the greatest source of medicine for the greatest amount of people. Although European and North American pharmacy derived drugs—drugs that are the product of the pharmaceutical industry—are used predominately by a relatively small proportion of the people, especially those living in cities, and are mixed, to a certain extent, with indigenous and available drugs often harvested in nature by a further substantial proportion of the people, the dependance of the human race, in which approximately 75 percent of all the people in the world find their primary drugs from plants occurring in nature or semi-cultivated, is very important. Even among the major prescription drugs that are used in parts of the world that have moved away from this tradition, most of them are either slightly modified natural products. For example, aspirin, which is derived by very slight modification from a precursor found in the bark of willow trees in Europe and chewed and used there, and then made into the commercial drug aspirin; or steroids, which are changed into cortisone or birth control ingredients, were initially harvested from wild yams, largely in Mexico but later grown in solariums. Items like tubocurarine, which is a derivative of curare, was detected because it was noticed that people were hunting with arrows dipped in curare and tubocurarine; in Western medicine, this is the muscle relaxant (the relaxant of the diaphragm) that makes possible all open heart surgery. Among recent drugs, which are used unaltered, could be mentioned: vinblastine or vincristine, which cures childhood leukemia and is obtained from Ca-
tharantlius, the rosy periwinkle; or taxol from yew trees, Taxus; or artemisin from Artemisia annua, a prophylactic against the plasmodium organisms that cause malaria.

There are many ways—and this leaves aside cotton, clothing, building materials, the opportunities for producing biomass, and many other things like plastics, and other things that plants can now produce as we learn more and more about them—in which we are completely dependent on biodiversity. How familiar our dependence on the ecosystems and the communities that organisms make up is to all of us in the scientific community, but unknown to most of those who are in a position of making decisions. The forests that clothe our mountains not only provide pure water in our watersheds, but a steady source of wildly harvested plants and animals and other commodities. They guard the often fragile soils of tropical communities, provide goods in purifying the atmosphere and waters and regulating the cycling of minerals in the soils in ways that we understand only in a sketchy manner. All these ecosystem services, worth hundreds of billions of dollars, are provided to human beings free of charge every year. But if we do not respect those ecosystem services and understand the ways in which they support us, we are apt to fall prey to false arguments about the fact that the development, or the clearing, or the extirpation of huge areas of our countries are necessary for short term economic gain, and to view it all as a continued battle between the environment and economy.

It is a tension between human development and the environment that supports us, but nothing we do can take place outside of that environment on which we must ultimately depend for our sustenance and for every single good that makes our lives possible.

As the head of the foundation recently established by Ted Turner to support the United Nations, former U.S. Senator Tim Wirth put it, “The economy is a wholly-owned subsidiary of the environment.” Whether we want to think about poetry, economics, love, hate, medicine, law, or anything else that we want to do or that we want to accomplish, we can only enjoy the ability to do that within the context of an environment, and we are absolutely regulating that environment.

Finally, I could not leave this brief compilation of the advantages of biodiversity and its benefits for us without cataloguing its spiritual and its aesthetic quality. Human beings evolved in a world in which they were dependent on the rich array of biodiversity that had grown up around the world particularly over the 65 million years since the terminal Cretaceous event. This event drove approximately two-thirds of all the organisms on Earth to extinction 65 million years ago. Humans developed in that rapidly evolving world, and our minds must have been formed by, and through, our ability to communicate about the biodiversity, some of which threatened us in the form of large marauding animals, poisonous plants, and other things that could be negative, some of which benefitted us as sources of food, medicine, and of everything else that our ancestors needed to make their way.

It seems perfectly clear that our cognitive abilities, our minds, our whole system of language, our whole orientation to the world is built up around our ability to understand and to communicate around the biodiversity on which we so seriously depend. It is a small wonder that every great religious and thought system in the world has special prohibitions against the destruction of biodiversity, and the ecosystems that biodiversity makes up; and a small wonder that these great thoughts and philosophical systems are so appealing to us, and are so important as part of the ethical mixture with which we must all find our futures together. Of course, a simpler way of noting it is just by realizing how much we enjoy having plants and animals, pets, dogs, cats, fish, and trees and gardens around us. They refresh our spirit, and we rejoice in their beauty. Much of our art finds its original inspiration in interpretations of the natural beauty of organisms. A small wonder that that would be the case when one thinks about the extraordinary close linkage between the development of our own potentialities, and our abilities, and the biodiversity that makes this a marvelously beautiful and wonderful living planet.

Unfortunately, as we all know, and as I will review very briefly, the destruction of biodiversity, the systems that individual organisms make up and the genetic variability of those organisms, which gives them ecological and evolutionary resilience, is being destroyed at an extraordinarily rapid rate. Our planet is 4.5 billion years old. Life appeared on Earth probably some 3.5 billion years ago, and possibly 4 billion years ago. For the first couple of billion years on Earth, all of that life consisted of bacteria. One of those groups of bacteria, the cyanobacteria, through their extraordinary photosynthetic activities projected over billions of years, changed the atmosphere, as I have already said, to one with 20 percent oxygen, which is something that we depend on, and also gave rise to the deposits of petroleum and natural gas on which the Industrial Revolution based itself.

Multicellular life is approximately 700 to 800 million years old, but one thing we often do not think about is that life on land, life coming up on the continents, is only about 430 million years old. In other
words, 90 percent of the history of the Earth went by before any organisms came up on the land, before there were plants, before there were anthropoids, fungi, vertebrates, and before the evolutionary line that ultimately gave rise to us, came up on the land. Some 90 percent of the way through the history of our planet, forests, which we take for granted at the present time, and strive and struggle to preserve, and which contain a majority of the living things on Earth, appeared approximately 300 million years ago for the first time, becoming increasingly diverse, and also through their accumulative activities giving rise to the coal deposits, which are the third major source of energy in the Industrial Revolution, starting about 300 million years ago; and, of course, in a process that continues up to the present time.

Human beings appeared approximately two million years ago, and our species approximately several hundred thousand years ago. The key statistic, and the one on which all considerations of sustainability revolve, is the fact that approximately 10,000 years ago, our ancestors developed agriculture independently at various centers here in Mexico, Peru, Asia, South Asia, and possibly along the Yangtze and Yellow Rivers and certainly in Africa and in the Eastern Mediterranean. At the time that our ancestors developed agriculture, the entire human population of the world consisted of approximately 3 to 4 million people. In other words, there were approximately one-fifth as many people in the entire world a mere 10,000 years ago, just before the dawn of recorded history, on all of the continents (Australia, Eurasia, Africa, North and South America) as there are in Mexico City. In other words, there were about as many people in the entire world as there are visitors to the beautiful Museo de Antropología here in Mexico City during the course of a year. Looking at it in another way, human beings were spread out like Aborigines in Australia before European contact, or like the bushmen in South Africa living as hunters-gatherers.

As you all know, for better or for worse, the invention of agriculture gave people the ability to accumulate food for unfavorable seasons and to build villages and towns and cities, and to specialize in their professions among other things to become botanists, and to hold Latin American Botanical Congresses in ways that would have been impossible when they were spread out and widely scattered. Human beings had a basis for waging war with one another—they had large stores of food that they could fight about, and they domesticated horses and began running around and fighting one another, and taking that territory that you could grow things on, and giving it away, conquering it, building up nations, and building up the form of the world that we have at the present time. But remember, the whole incredible journey, from a time when human beings were about as abundant as many, many other species of animals in the world to today when 6 billion of us, in ways that I am about to catalogue, are chewing away at the productivity of the world and destroying it, homogenizing it, and reducing it; that entire journey is nearly congruent with written human history on Earth—a mere 10,000 years.

Human numbers began to rise very rapidly with the invention of agriculture and the ability that it gave people to specialize, so that by the time of Christ, there may have been approximately 150 million people in the world, more than there are in Mexico now, 33 percent more; and by the Renaissance in Europe, about one half billion people in the world (about 500 million) in the entire world, which is just about the population of Latin America in the present day, and then, with further growth, up to about 1 billion people at the beginning of the Industrial Revolution, around the year 1800. In the early decades of the Industrial Revolution, an English clergyman named Thomas Malthus was warning of the impending disaster that would come because human beings would be unable to grow food as rapidly as their populations would grow. Malthus proved to be wrong, because people began applying the energy that they were deriving from coal, oil, and gas, and the machines that they made, the fertilizers that they learned how to make artificially, and other kinds of improvements, mechanical plowing and so forth, to the production of food. The human population kept growing so that in the next 130 years, by 1930, there were 2 billion people; by 1950 there were 2.5 billion people, and now as the millennium comes to its end, approximately 6 billion people in the world.

The point that I want to make very firmly for you is that there is no room (and I will come back to this, but let me state it this way at the beginning) for major development along the lines that we have enjoyed over the past 200 years. If we are living in a dream that the world will continue to use the tools that were developed over the 200 years of the Industrial Revolution to go on and find further prosperity in the future, it is time that we awaken and begin looking at the world as it really is. Let me tell you why.

Everybody says that over the past 50 years, human beings have accomplished wonderful things in increasing the world food supply to feed all the people in the world. Are all the people in the world fed? Well, there is 6 billion of us: 1.5 billion, a quarter of all the people in the world, live on less than US $1 per day, the condition that the World Bank defines as absolute poverty. Half of those people, about 700
millions of them, subsist on less than 80 percent of the U.N. recommended caloric intake per day. In other words, when they are babies, their brains cannot develop properly, and when they are adults, their bodies are wasting away. Approximately 14 million children under the age of four starve to death every year (about 35,000 a day). The women and children who live in those countries, 700 million poorest and hungriest people in the world, have no opportunities at all to contribute to the advancement of the world because their days, as you know, are filled with going out and getting water, often at a distance of 20 kilometers or more, or firewood from equally distant locations. They have no chance for education, the children have no chance for education, and most seriously for the future of the human race, they are not in a position to be able to contribute to a flourishing and rich human society in the future, because we, whoever we are, the functioning of the human race and all the systems of nations on Earth, have them in a situation in which they have no opportunities whatsoever. This is an appalling kind of condition. But moving now to looking at the last 50 years, what has happened during those years, among other things, are the following.

Twenty-five percent of the topsoil in the world has been lost. Go down along the roads of steep fields or slightly inclined fields in Mexico after a rain: you all know what happens, and the style of cultivation that we have. Worldwide, this has amounted over the past 50 years, along with population growth and more demand for food production, to an enormous loss of resources. Twenty-six billion tons of topsoil are still lost every year; 15 to 20 percent of the agricultural land that was being utilized to feed people 50 years ago has been lost during the last 50 years to urbanization, to desertification, to mineralization, and to over fertilization and is no longer available. If you just look at those two statistics together and count the fact that one-third of all the forests in the world have been cut down over the past 50 years, you realize that to say that we have kept pace with human population and feeding people, while it contains some truth, is a charade, it is a lie. It is a comforting kind of pseudo-truth that we can believe, but which will mislead continuously and just allow us (give us license) to spoil ourselves and to consume in some way, in the way we are consuming now. It really puts the world in the position of a family who gets $1 million from an inheritance, and over the next four or six years spends it at the rate of $200,000 a year, thinking our lives have greatly improved and we are looking forward to all the pleasant years that are yet to come; and then they go and look at their bank account and it shows no money. So, what to do about it? In other words, just as in that case, what we are doing as a human society is we are spending the principal, and we are not living off the interest.

This kind of thing, as well as the profound changes in the atmosphere that have occurred over the past 50 years, have raised the carbon dioxide over 15 percent, have depleted the global ozone layer, and thus increased the incidence of malignant skin cancer in these latitudes by about 20 percent. Worst of all, in driving the rates of extinction worldwide up to about 10,000 times their historical rate—at a rate of increase that threatens to drive about one-quarter of all the kinds of organisms on Earth to extinction over the next 25 years—a greater proportion than became extinct during the end of the Cretaceous when the giant asteroid hit off the end of what is now the Yucatán Peninsula, and clouded the whole world in such a way that lots of organisms became extinct, with life taking 10 million years to recover. We are living in the middle of an extinction crisis worse than the Cretaceous event, and only one entity, namely ourselves, is responsible.

I want to be very clear in leaving this section that population levels are only one component of the destruction of the world’s resources, over which we are collectively presiding. The other terms are, of course, affluence, rate of consumption, and technology that is utilized. And we, as botanists and as scientists, have a great deal to contribute to both of those areas. If everybody in the world lived by the standards that we do in the United States, or people do in Europe, or wealthy people do in Latin America, one of my colleagues has put it this way, “We need two more planet Earths to support us right now; we cannot go on living with the inequities that are present in the world at the present time, we cannot do it.”

A lot of what is wrong with this is the consumption rate that is leading to pure wastefulness, and the use of inappropriate technologies by not being wise enough or proper enough to find out what kind of technologies could be more saving. Of course, the world needs to find a population balance that it can accommodate, and then it needs to find, and this is the most important thing that I want to say, new ways of thinking and new ways of operating.

In a way, the report of the World Commission on Environment and Development (the Brundtland Report) was a properly, widely praised document, and after being completed, it was adopted by the United Nations General Assembly and held up as a model of the ways in which we could all work together. Another way of looking at it, though, if you read the summary and think about it carefully, what it really says
the United States and the United Kingdom are no exception, worries profoundly about what scientific and technical fields each should emphasize, and which ones each should use for its national funding in order to be able to develop within that country. All countries in the world are not confronted with a whole panorama of scientific and technical innovations, which they could, in most cases, adopt within their countries to some advantage. All countries in the world, without exception, feel that if they develop science and technology in certain fields, whatever they develop will soon be stolen from them and put to use somewhere else before they can get any real benefit from it.

The simple proposition that I would like to make is that although some countries are very well developed in science and engineering, and the technologies that go along with it, other countries have modest endowments. There is no country in the world that lacks a university and some scientific and technical knowledge on which it can elaborate itself and develop itself better for the future. I think that is absolutely necessary within the limits of possibility for every country in this region, and for every country throughout the world to elaborate to the extent that it can as many different current areas of science as possible.

Although it is obviously a matter of first priority for countries to pay attention to sustainability and the ways in which they might find sustainability of their own natural resources for their own benefit, I also hold that no country can participate fully, or take advantage of the scientific and technical advances that are being made all around the world, if it does not have its own scientific and technical capabilities to understand the basis of those advances, and to be able to appropriate them for itself in a meaningful way that will serve the interests of its people best.

I really would say two things in the way of friendly advice. Do not concentrate exclusively in national priorities on the very cutting edge of science. Do not concentrate exclusively on molecular, cellular, and structural biology because most countries cannot be at the very forefront of that and most countries have lists of other needs. But, by all means, do not neglect those extraordinarily important fields either. Everybody has to have enough capabilities to understand what is going on in order to be able to deal with questions like the meaning of genetically modified organisms, the meaning of new medicine, the appropriation of bioengineered plants, and how the world is going to develop energy systems in the future. You can only do that in a comfortable way if you have an academic enterprise within your own country and if every country is devoted to that goal. I simply want to encourage everybody not to lose the faith with that one. It is a loss to do so, and a handicap in winning opportunities for the future.

I will offer a minute or two of concluding remarks, but before I do that, I want to just make an announcement. If you have not noticed that the XIV International Botanical Congress will be held in St. Louis next summer in the first week of August, its information is available on the Web. We are treating the Congress as a North American Congress, and we are sponsoring it between Mexico, Canada, and the United States, so we all have a stake in it. Please be sure that your colleagues are well familiar with it, and will take advantage of what we have to offer there.

Let me conclude then by summarizing what I have said. Sustainability is necessary for global futures. In order to attain sustainability, we have to not all rise to the most horrendous and destructive levels and operations that we have going on in the world now. We all have to participate in the great and fundamentally important adventure of developing the new ways of thinking that will make the world of the future the kind of place that we want it to be for our children, and our grandchildren, and their grandchildren indefinitely. Within 25 years, the population of the United States will be one quarter Latin American. The United States has no great defining principle involved in it. It is not racially one way or the other. Join with us and all the nations of the hemisphere in the effort to find new ways of thinking, in this hemisphere, and combining the best resources that we have of all the people, to understand the enormous nature of the problems that we confront, and to find new ways of dealing with them. Nothing will be accomplished without warm, friendly, observant, careful, and respectful communication between all of us on all of the issues of interest. Although we are proud of what we can accomplish individually, we can solve this problem only by working together.

As we all know from looking back on the scenes of our childhood and evaluating them in an environmental sense, the world is inextricably becoming more and more homogenous, human cultures are being lost, and biological diversity is being lost. There is nothing that we can do to stop the world from becoming a more homogenized place. But what will the world look like when it finally does attain sustainability, which it will? What it will look like will be colored by, shaped by, designed by, and fashioned by our efforts, our best abilities, our best collegial efforts, our coming together to build the better world and define those new ways of thinking and supporting one another responsibly that we desperately need and we so urgently want.
In that spirit, and for those reasons, I conclude right where I began, by congratulating you all for the enthusiasm and the spirit of adventure and the spirit of determining to do something better in the future that has brought us all together here in Mexico City now. I would say again that it has been a privilege for me to be able to present these remarks today as you start these meetings, which I am sure will be productive in every sense of the word.

Thank you very much.