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Intergovernmental Oceanographic Commission

ROGER REVELLE MEMORIAL LECTURE

Roger Revelle was a pioneer in oceanography and in global ocean science cooperation. He was one of the first scientists to cite a potential for human-induced climate change and to point to the role of the ocean in the climate system and in climate variability. Oceanography is an interdisciplinary science requiring international cooperation; it should not be restricted by academic disciplines or territorial interests.
Roger Revelle was convinced that the efforts required for an adequate study of the ocean exceeded the capabilities of any one country, and accordingly, he was one of the founders of the Intergovernmental Oceanographic Commission of UNESCO

R. Revelle memorial lectures (Decision 16th IOC Assembly, 1991; to be delivered at Executive Council sessions): to address marine geology, geological oceanography, and institutional co-operation in these fields and in general, at the national and international levels.

The Roger Revelle Medal

Celebrating...one of the founding fathers of the IOC of UNESCO

Roger Revelle (1909-July 1991) was a pioneer in oceanography and in global ocean science cooperation. His 1979 address on climate to the Eleventh IOC Assembly was a typical Revelle *tour de force*. As one of the first scientists to point to the role of the ocean in the climate system and in climate variability, he began *'I am about to describe what I believe to be the most important programme that has challenged the IOC in many years.'*
* Extract courtesy of 'Roger Revelle and his contribution to International Ocean Science' by the honourable John A. Knauss, Revelle Memorial Lecture, 1992.

'His dream of equity in human relationships, based on equal access to education and knowledge ... was indeed reflected in every endeavour he undertook, including the rationale for an intergovernmental body for ocean research that resulted in the establishment of our Commission.'
* Mr Federico Mayor, Director-General, UNESCO, paying tribute to Roger Revelle on the occasion of the Twenty-fifth Session of the IOC Executive Council, 1992.

Extract from IOC Annual Report 2004 (page 18):

Now an established tradition, every session of the Intergovernmental Oceanographic Commission's annual Executive Council opens with the hallmark Revelle Memorial Lecture. Named in honour of Roger Revelle, whose important contributions to the awareness of global change form the basis of many IOC initiatives today, the invited lecturer's research reflects much of the same pioneering spirit and aspirations as Revelle's, and by association, the ideals that originally led to the creation of the IOC forty-four years ago. To formally honour Revelle's focal role in helping to create the IOC, Dr Patricio Bernal, IOC's Executive Secretary, announced the award of a 'Roger Revelle Medal' to all Revelle Memorial Lecturers, starting on the occasion of the Thirty-seventh Executive Council, 2004. The Roger Revelle Medal recognizes outstanding contributions to the ocean sciences by inspired researchers who communicate their knowledge and global vision of the challenges facing our Planet in order to shape a better future for humankind.

Mrs Mary Ellen Revelle Paci, daughter of Roger Revelle, expressed her thanks to the IOC for this initiative and for offering her family the first IOC Roger Revelle Medal*.

This year's lecturer and medal award recipient, Daniel M. Pauly, Professor and Director at the Fisheries Centre at the University of British Columbia, Canada, said, 'I am not only delighted, but deeply honoured to have received the Roger Revelle Medal. It commemorates the work of a scientific giant, and being associated with his name – never mind standing on his shoulder – is something I am quite proud of.' Dr Pauly spoke on Upper Trophic Level Changes in Ocean-basin Ecosystems. Ecology, and Evolution (2004) and is available from Cambridge University Press.

See below the list of R. Revelle Memorial Lectures since 1992.

1992 Twenty-fifth Session of the Executive Council, 10-18 March 1992
Roger Revelle and his Contribution to International Ocean Science, by John A Knauss
(see full text below)

1994 Twenty-seventh Session of the Executive Council, 5-12 July 1994
Ocean Research in Developing Countries, by S.Z. Qasim

1998 Thirty-first Session of the Executive Council, 17-27 November 1998
An Overview of International Co-operation in Marine Research and Ocean Observations: Some Perspectives with Reflection on the Role of IOC, by Gunnar Kullenberg

2000 Thirty-third Session of the Executive Council, 21 June 2000
Responding to Climate Change: Scientific Questions Regarding the Possible Disposal of CO_2 in the Deep Ocean, by Peter G. Brewer

2002 Thirty-fifth Session of the Executive Secretary, 5 June 2002
The increasing role of remote sensing in ocean science and operational oceanography; and its potential role in sustainable development, by Gregory G. Withee

2004* Thirty-seventh Session of the Executive Council, 23 June 2004
Upper Trophic Level Changes in Ocean Basin Ecosystems, Daniel M. Pauly

2006* Thirty-ninth Session of the Executive Council, 21 June 2006
Global Sea Levels: Past, Present and Future, John Church

2008* Forty-first Session of the Executive Council, 26 June 2008
Impact of Climate Change on the Marine Environment
- The Operational Oceanographic Service for sustainable development and management of marine resources: a unified approach, Nadia Pinardi
- Arctic Observations: meeting the needs of operational ocean forecasting, climate monitoring and all the time-scales in between, Cecilie Mauritzen
- Impacts and Responses to Sea-Level Rise, Robert J. Nicholls

2010* Forty-third Session of the Executive Council, 10 June 2010
Learning to swim: exploring the challenges to marine resource sustainability,
Manuel Barange

2014* Forty-seventh Session of the Executive Council, 1st July
The CARIACO Ocean Time-Series Project: a window into oceanography in Venezuela, Prof. José Marín Baumar Marín Espinoza and Ms Máyida El Souki

2016* Forty-ninth Session of the Executive Council, 8 June 2016
Ocean acidification and other stressors on marine systems:
How can we help the oceans help us?
Prof. Ken Caldeira, Climate scientist, Carnegie Institution for Science (USA)

2018* Fifty-first Session of the Executive Council, 5th July
Roger Revelle: friend and mentor
Walter Munk, Secretary of the US Navy, Chair in Oceanography at Scripps

2022* Fifty-fifth Session of the Executive Council, 16th June
Climate change is ocean change: a physiologist's view
Prof. Dr Hans-Otto Pörtner, Alfred Wegener Institute, 27570 Bremerhaven, Germany

2024* Fifty-seventh Session of the Executive Council, 27 June

ROGER REVELLE MEMORIAL LECTURE 1992

13 March 1992

Introductory Remarks
by
Mr. Federico Mayor
Director-General
United Nations Educational, Scientific and Cultural Organization (UNESCO)

It is a pleasure and an honour for me to introduce this first lecture in honour of Roger Revelle. I would like to share briefly with you my personal recollections and esteem for a man who was a giant in every sense of the word: physically, mentally and spiritually.

I first met Roger in the late 1970's in connection with UNESCO's research on basic human needs programme, which owed much to his dream of equity in human relationships, based on equal access to education and knowledge. This ideal was indeed reflected in every endeavour he undertook, including the rationale for an intergovernmental body for ocean research that resulted in the establishment of our Commission.

As one of the authors of the Copenhagen Declaration, he stated most clearly in 1960, the importance of the ocean to humanity as a whole and the need to study the ocean from many points of view, and through the concerted action of all nations. His foresight of three decades ago was remarkable. At a time when the ocean was viewed by most as basically a source of food and a medium for transportation, Roger inserted into the Declaration the following:

"The oceans exert a profound influence on mankind and indeed upon all forms of life on earth. The oceans are inexhaustible sources of water and heat, and control the climate of many parts of the world."

Reading the other week an account of a recent article in Nature on investigations in the North Atlantic Deep Waters highlighting the links between the ocean and climate, I thought immediately of Roger and his visionary approach to everything he undertook.

His intellectual curiosity and commitment to human needs was by no means limited to ocean research itself. A man -- an American -- with a truly global vision of humanity, he also devoted his energy to world problems such as desertification and possible solutions through the green revolution.

Speaking with Roger on these matters was always a stimulating and rewarding experience. He was a man of dialogue and those who had the privilege of sharing ideas with him found the frontiers of their own minds considerably expanded. I would like to emphasize the solidarity of this great man with the whole world - he, for one, certainly welcomed the expansion of the IOC and its TEMA (Training, Education and Mutual Assistance) commitment to help establish marine science capabilities and sustained ocean observations in support of the development of the Third World.

His commitment to the world community led him some years ago to organize a "think-tank" session at the University of San Diego to explore with others the question of "Restructuring UNESCO" with a view to restoring the universality of the Organization. I was most honoured to receive an invitation from Roger at that time and contribute with him to the proposals that emerged from the meeting. And, only two years ago, he invited me to his house at La Jolla to once again explore the subject, but this time based on the restructuring already accomplished.

When exceptional individuals such as Roger disappear from the world community, they leave behind them a huge gap but also a mission to all of us, as individuals and in our official capacities, to further the goals to which he was committed. We can't all be giants, but each of us can contribute, knowing that his influence will be present in our endeavours.

This is the essential legacy left bv Roger Revelle: not onlv his work as a pioneer in the Field of international co-operation in ocean science and as one of the founding fathers of the IOC of UNESCO, but also his implicit call to all of us to promote to the best of our ability the vision of equitv and universality that he embodied. It now gives me great pleasure to give the floor to Dr. John Knauss, First Vice-Chairman IOC, to speak to us about Roger Revelle and his contribution to ocean science.

ROGER REVELLE AND HIS CONTRIBUTION TO INTERNATIONAL OCEAN SCIENCE

Bv the Honourable
John A. Knauss
Under-Secretary for Oceans and Atmosphere,
U.S. Department of Commerce,
and First Vice-Chairman of IOC

I am pleased and honored to be asked to give the First IOC Revelle lecture. My goal in this First Revelle lecture is to leave vou with some measure of the man and why so many of us believe it fitting that the IOC establish a Revelle lecture series. As I will attempt to demonstrate he was as responsible as any single person can be for the establishment of this. our own organization, the Intergovernmental Oceanographic Commission.

He was a visionary, a builder of institutions, a champion of international co-operation, a great scientist and an extraordinary warm and friendly person. He left his mark on many throughout the world.

He certainly left his mark on me. I am an oceanographer because of him. Like many of my generation I emerged from the vastlv changed world of World War II, confused and perplexed as to what I wanted to do. I had some training in meteorology and physics, was enamoured of neither, and was casting about for a career when I met Roger Revelle through a mutual friend. He steered me to a temporary position with the Navy in oceanography and 43 years later I am still at it. I eventually went to Scripps, where Revelle was the director, to obtain my PhD and to learn some proper oceanography. I was adopted by the Revelle family and served for a brief period as Roger's assistant in the Director's office. He was my major professor and co-chaired my PhD Committee. He remained a colleague, friend and adviser until his death this past July at the age of 82.

I give this resume so that you can judge my bias. In an era of too few heroes, Roger Revelle is one of mine.

Oceanographv changed rapidly after World War II, nowhere more so than at Scripps where Revelle had earned his PhD before the War and where he returned afterwards. Prior to World War II, Scripps was a small coastal marine station with very limited seagoing capability. But that was the situation almost everywhere. The major deep ocean programmes we are all so familiar with were, almost without exception, national expeditions -- one of a kind expeditions -- expeditions that took many years to plan and even more years to reduce findings to paper. They were the CHALLENGER, the METEOR, the DANA expeditions. Thev were grand, marvelous affairs, and the results were published in the multi-volume expedition reports.

All of that changed rapidly after World War II, and nowhere did it change more rapidly than at Scripps where Revelle was Director. He wanted to expand Scripps' horizons beyond the coastal water, and, with the help of two 43 meter Navy surplus ocean-going tugs, he did just that. The First was a single ship three month expedition called the MID PAC in 1950, and the second was a Five-month two-ships expedition called CAPRICORN in 1952-53. Both ranged widely over the Pacific. Both were led by Revelle. Since he was the Scripps Director, many thought he should have remained home and be the Director rather than wandering about at sea where it was difficult to communicate with those ashore. Remember that these were the days before voice ship-to-shore radio communications. All messages to and from the ship were by Morse code. Nevertheless, he led both expeditions from beginning to end.

In my view those two expeditions signaled a change in how oceanography was going to be done. Scientists from many disciplines were on each voyage, but no finely bound multi-volume expedition reports resulted. Instead the professional literature (biological, chemical, geological, physical), was filled with results from those programmes for many years thereafter. Major sea-going expeditions were going to become routine, not a once-in-a-lifetime opportunity with special expedition reports. More importantly for those of us at Scripps, it signaled a change in how we looked at our science. There were no longer any unspoken geographical boundaries. Assuming you could find the necessary funding for your programme, you could go wherever it was necessary to attack your problem.

Nor, we soon learned, were we unique. We were not the only institution or the only country sending ships far to sea. Europe was; and so, most dramatically of all, was the USSR. By the time the International Geophysical Year was completed at the end of the 1950's, it was clear that the world of oceanographic research had changed. The era of the multi-volume expedition reports had passed. There were many research ships in many oceans. New and wonderful discoveries were being reported regularly in professional literature. Plans for ever larger and more complex programmes were being discussed.

Was there need for better international co-ordination? Many thought so. The International Geophysical Year of 1957-58 was a tremendous success both scientifically and as a means of developing increasing international co-operation amongst the scientific community. I expect, however, that a close reading of the history of the IGY would show that the oceanographers came a bit late to the party. There was indeed an international oceanographic component to the IGY, and Revelle played a major role in developing it; but, except for the establishment of World Data Centers, it was mostly a loosely coordinated effort by a number of groups to develop individual programmes under the IGY banner. Through international planning meetings we got to know each other better, but I believe one would have been hard pressed to argue that the whole of the oceanographic IGY programme was greater than the sum of its parts.

Oceanography badly needed a better means of international co-ordination. Many understood that. What was less clear was how. There were a number of false starts before the IGY. The International Council of Scientific Unions (ICSU) established an International Joint Commission on Oceanography in 1951. Revelle was a member. It recommended the establishment of a Deep Sea Council, but two years later in 1953, ICSU apparently thought the group was going beyond its terms of reference and abolished the Commission. ICSU tried again a year later with the establishment of a Special Committee on Deep Sea Research. Revelle was made a member of that as well. In 1955, UNESCO in a parallel effort, established an International Advisory Committee on Marine Sciences to advise the Director-General on the preparation and execution of UNESCO's marine programmes. Revelle, along with Anton Bruun of Denmark and George Deacon of the UK found themselves members of both committees.

All of this was going on while the International Geophysical Year of 1957-58 was being planned. As the IGY was about to start, the President of ICSU, Lloyd Berkner, suggested to Revelle that a suitable follow-on to the IGY would be an international co-operative programme in oceanography. He then asked Revelle to organize a special committee for that purpose.

I believe Berkner's decision signaled the end of the confusion. From that date one can clearly trace the establishment of SCOR, the Special (later renamed Scientific) Committee for Oceanographic Research, the Intergovernmental Oceanographic Commission and the great joint effort of both organizations in their formative years - the International Indian Ocean Expedition.

SCOR was established in 1957, the year of the IGY. At its first meeting in Woods Hole, Roger Revelle was elected Chairman, George Deacon of the UK was Vice-chairman and Gunter Bohnnecke of Germany was Secretary. It was agreed that the principal objective of SCOR should be *"to encourage and co-ordinate an international programme of observations and measurements of deep ocean water."* Also from that first meeting came an agreement to mount a major international oceanographic effort on that most unknown of oceans, the Indian Ocean.

The history of how that expedition developed is told in a charming book published some years ago by The UNESCO Press entitled "Assault on the Largest Unknown - The International Indian Ocean Expedition" by Daniel Behrman. As an active participant of that expedition I can vouch for its authenticity.

Once it was clear that there was to be a concerted effort to study the Indian Ocean, ideas flowed quickly. What began as a one-year highly structured programme became a six-year multifaceted effort. The original concept of a systematic survey was lost in the entrepreneurial enthusiasm of many scientists from all over the world.

Revelle, Deacon and Bruun spent the summer of 1960 in Copenhagen pulling together the various components of the International Indian Ocean Expedition (IIOE), into a coherent plan that could be presented to SCOR and to governments. It was not an easy task. Warren Wooster who was the first IOC Secretary has written, *"I think the International Indian Ocean Expedition was the greatest uncoordinated expedition in oceanographic history. I ought to know. I was coordinator part of the time. It was the only way to explore such a region. Scientists with curiosity would not have come in, if it had been done any other way."*

The reason why Wooster was the Indian Ocean coordinator was that the IOC took over from SCOR the responsibility of the Indian Ocean Expedition in 1962, and the reason it did so was that Roger Revelle and others realized that there were limits to what a non-governmental organization like SCOR could do.

In July 1960, that same Copenhagen summer that Revelle, Deacon and Bruun were attempting to pull together the various strands of what was to be the International Indian Ocean Expedition, UNESCO held an Intergovernmental Conference on Oceanographic Research in Copenhagen. Roger Revelle led the US Delegation. The Conference recommended the establishment of the Intergovernmental Oceanographic Commission, the IOC-, a recommendation that was subsequently approved by the UNESCO General Conference. In 1962, the IOC took over the co-ordination of the International Indian Ocean Expedition with SCOR remaining in an advisory role.

The need for the IOC flowed directly from the plans of SCOR and the Indian Ocean programme. As Revelle and others noted, the aspirations of oceanographers to continue the momentum of the IGY, to carry out the vast international co-operative programmes envisaged for the Indian Ocean, required some form of intergovernmental organization. It could not be left to non-governmental organizations alone. Programmes of this size and complexity often require formal government commitments.

During this period Roger Revelle managed two other projects I would like to note. As President of SCOR, he arranged with the American Association for the Advancement of Science (AAAS) to hold the first International Oceanographic Congress in 1959. He was President of the Conference and with typical Revelle aplomb he managed somehow to have the Congress held in the United Nations Headquarters in New York. I was fortunate to participate in that first Congress, and I still remember my sense of wonder as I watched some of my more senior colleagues delivering their plenary addresses from the same lectern that heads of state had addressed the U.N. General Assembly just a few months previously.

It was also during this period that Roger Revelle and Harry Wexler of the U.S. Weather Bureau agreed to sponsor a young Ph.D. chemist who was convinced that he could make continuous carbon dioxide measurements with a routine accuracy that no one had yet attained. These were the start of what many have referred to as the most important set of environmental measurements of this century, the carbon dioxide observations of the Mauna Loa Observatory in Hawaii which began in 1958 and continue to this day under the same watchful eye of Charles David Keeling.

There had been suggestions for some time that perhaps there was an increase in the carbon dioxide content of the atmosphere as a result of the burning of fossil fuels. Revelle agreed. He had done early research on ocean carbonates and the ocean carbon dioxide cycle. He and Hans Suess published a paper in 1957 in which they predicted that the ocean could not absorb more than 50% of the carbon dioxide released by the current rate of burning of fossil fuels; carbon that had been secreted by the earth for millions of years.

As Revelle noted in one of his oft quoted epigrams, *"we are now carrying out a large scale geophysical experiment of a kind that could not be carried out in the past or be reproduced in the future."*

Keeling quickly justified Revelle's and Wexler's faith. The first results were confusing; the CO_2 level first rose, then fell and often there were gaps in the data because of an inconsistent power supply at that remote mountain-side location. But by the end of the second year, however, the pattern was clear. There is a seasonal pattern tied to the plant cycle superimposed on a yearly increase of carbon dioxide of about half a percent a year.

Thus began the set of measurements that have convinced the world that mankind can indeed have a global effect on climate. The now familiar saw tooth curve of carbon dioxide which shows about half a percent per year increase in carbon dioxide now graces every report pertaining to global warming. One may argue about how much warming will take place and how fast it will take place because of the slow but inexorable climb in CO_2 concentrations, but there is no argument about the data.

In 1964, Roger Revelle took an 11 year leave of absence from oceanography when he left the University of California at San Diego to establish the Harvard University Center for Population Studies. He returned in 1975 at the time of his Harvard retirement.

His enthusiasm for international science never flagged. He strongly supported the internationalization of the Ocean Drilling Programme which had begun as a US programme. He continued to serve, and often lead international programmes. He was the first Chairman of the United States Committee for the International Biological Programme. He served as a US Delegate

to the UNESCO General Conference on 4 occasions and to the General Assemblies of ICSU for 22 years. He served as an adviser to the governments of India, Pakistan, Bangladesh, Nepal and Sri Lanka.

In 1979, Roger Revelle returned to the IOC he had helped to form. He came as Chairman of a new Joint SCOR-IOC Committee on Climate Change and the Ocean, the CCCO. His 1979 address on climate to the Eleventh IOC Assembly was a typical Revelle tour de force. He began with the words*, "I am about to describe what I believe to be the most important programme that has challenged the IOC in many years."* He then proceeded to strip a very complex subject to its essence without trivializing it, having something to say to the expert as well as to the layman. He evoked the excitement of the present scientific studies and plans for the future. He held out hope of the extraordinary social and economic benefits that would result if we could indeed predict the strength and timing of the Indian Monsoon, the East Pacific El Nino, or the yearly rainfall in Russia or Northern Africa. Most importantly for his IOC audience, he demonstrated the role of the ocean in climate variability.

He finished with these words, *"In concluding, let me say that there are two important aspects of the world climate problem. One is statistics, that is the average conditions and variance. And the second is the possibility of actually forecasting climate. We cannot forecast it now; we may never be able to forecast it, but if we could, the results would be so valuable that the gamble is worth taking. And I conclude by emphasizing what I have said in the beginning, that the World Climate Programme and the possible role of the IOC in that programme represents the greatest challenge and the greatest responsibility that this body in my experience has ever had."*

Roger Revelle was largely responsible for the formation of SCOR, the International Indian Ocean Expedition and the IOC. An IOC whose major effort during its first 15 years was the facilitation of ocean science. I find it interesting that Revelle should have resurfaced at IOC in 1979, some 18 years after the 1961 meeting, to sound the call for a new challenge for IOC, the development of the necessary programmes that will allow us to monitor and perhaps to predict climate variability.

We have made progress in meeting the challenge that Revelle laid before us in 1979, but we have much more to do. That task is more important now than it was a dozen years ago. Revelle was properly cautious in not claiming that we would be able to forecast climate variability. He only held out the promise that if we could, the rewards would be great and therefore the risk was worth taking.
We are increasingly confident that we will succeed. our understanding of the tropical Pacific Southern Oscillation is sufficient that we are already having some success in forecasting El Nino events. Most believe it is only a matter of time before other climate forecasts will be possible.

All such forecasts, however, require better monitoring of the ocean. We must develop a global ocean observing system comparable to the international weather observing system.

In conclusion, I hope that whoever gives the Revelle lecture in the year 2000 can look back at the IOC and note that Roger Revelle's call in 1979 for the IOC to address climate variability was as important in shaping the IOC of the year 2000, as was his insistence in 1960 that there be an intergovernmental body such as IOC to facilitate international marine science.