



Balzan Prizewinners

Interdisciplinary Forum

2012

David Charles Baulcombe

(Epigenetics)

Ronald M. Dworkin

(Jurisprudence)

Kurt Lambeck

(Solid Earth Sciences, with emphasis on interdisciplinary research)

Reinhard Strohm

(Musicology)

Thursday, 15 November 2012
at the Accademia Nazionale dei Lincei, Rome

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Foreword

Alberto Quadrio Curzio, Member of the Board of the International Balzan Foundation “Prize”, Chairman of the Joint Commissions (International Balzan Foundation “Prize”-Accademia Nazionale dei Lincei-Swiss Academies of Arts and Sciences) and President of the Class of Moral, Historical and Philological Sciences of the Accademia Nazionale dei Lincei

This Balzan Prizewinners’ Interdisciplinary Forum is the outcome of cooperation between the International Balzan Foundation “Prize”¹ and the Accademia Nazionale dei Lincei² and the Swiss Academies of Arts and Sciences³. These agreements⁴ between the Balzan Foundation and the two national academies, which are articulated through joint commissions, are designed to set in motion and sustain a series of initiatives. There have been three important initiatives to date: an annual lecture, an interdisciplinary forum and an academic laboratory. The Annual Balzan Lecture, inaugurated in 2009 and now in its fourth edition, has resulted in a series of academic publications⁵. When the awards ceremony is held in Rome, an Annual Balzan Lecture is held in Switzerland and when the ceremony is held in Bern, an Annual Balzan Lecture is held at the Accademia Nazionale dei Lincei in Rome.

The Interdisciplinary Forum, which this year has been held in Rome, continues the tradition established in 2009 of involving the Prizewinners in an interdisciplinary discussion that is intended to stimulate productive academic debate. An interdisciplinary approach is what in particular marks out the Balzan Foundation in its endeavours to disseminate academic learning to a wider audience. The fields of our prizewinners as ever this year range widely, though also echo in interesting ways amongst themselves. They stress the impact on humanity of its immediate surroundings, both natural and artificial and the effect that man is having on his environment and his future in many differing ways.

¹ See profile p. 76

² See profile p. 76

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⁵ The Annual Balzan Lectures: 1. *The Evolution of Darwin’s Finches, Mockingbirds and Flies* by Peter and Rosemary Grant, Olschki 2010; 2. *Humanists with Inky Fingers. The Culture of Correction in Renaissance Europe* by Anthony Thomas Grafton, Olschki 2011; 3. *Cognitive Archaeology from Theory to Practise. The Early Cycladic Sanctuary at Keros* by Colin Renfrew, Olschki 2012; 4. *Fair Society, Healthy Lives* by Michael Marmot, Olschki (forthcoming 2013).

This year also marked the inauguration of IinteR-La^b, an academic laboratory which is essentially an opportunity for many of the young researchers working on the Balzan Prizewinners' Research Projects to become involved in interdisciplinary exchanges under the guidance of previous Prizewinners.

The contributions of this year's Prizewinners as published here, I am sure will resonate widely and stir debate.

Welcome Address

Alberto Quadrio Curzio

Professor Salvatore Veca, Professor Salvatore Califano and myself had a “long discussion” of about ten seconds on what language we should use and we have decided that each speaker should use the language he prefers. Thus since I prefer Italian, I will speak in English being unable to speak Latin. This is an example of the principle of multiple contradiction, a basis upon which every university professor operates.

I would like to convey to you a warm welcome from the Accademia Nazionale dei Lincei and its President, Professor Maffei, who will join us later. He is currently engaged in a meeting convened to discuss culture with reference to politics, where the President of the Italian Republic, who received us yesterday, and leading politicians are also in attendance.

When I inaugurated, two days ago, what I have christened IinteR-La⁺b, I briefly outlined the history of the Accademia Nazionale dei Lincei, something that Professor Califano and my other colleagues know much better than I do. Usually when I open a meeting of any kind, I do not have a formal approach, but like to establish some context by referring to the past because I believe that this is very important. I think it is worth a few minutes of our time to examine the iconography on these walls, including this relief of Federico Cesi, Prince of Acquasparta, who designated himself *Consensus princeps et institutor* (Prince and Founder) of the Academy and, of course, the image of a pioneering early member, Galileo Galilei. I think that there is no better way to initiate proceedings than to refer to these two personages. Federico Cesi – it should be remembered – after founding the Academy at the age of 18 also had the courage to defend Galileo Galilei for many years, though unfortunately he passed away some years before Galileo Galilei himself.

It is a pleasure now for me to hand over to Professor Veca, Chairman of the Balzan General Prize Committee, who will open today’s Forum.

Opening Remarks

Salvatore Veca, Chairman of the Balzan General Prize Committee

Thank you very much, Professor Quadrio Curzio, for your opening remarks and your original choice of language in respect to your linguistic preferences. In terms of your comments concerning academic principles, I wonder what the implications might be for the theory of economics. I would also thank you for your excellent illustration of what a sense of the past means in regard to this illustrious institution, the Accademia Nazionale dei Lincei.

On behalf of the Balzan General Prize Committee, I welcome you all to the 2012 Balzan Prizewinners' Interdisciplinary Forum.

I wish to offer my heartfelt congratulations to David Baulcombe, Ronald Dworkin, Kurt Lambeck and Reinhard Strohm. I would like to thank the Accademia Nazionale dei Lincei for again hosting our Interdisciplinary Forum.

This Interdisciplinary Forum has now become a regular and very successful feature supplementing the Balzan Awards Ceremony. The Forum is the fruit of external cooperation. I would once again thank my colleague Alberto Quadrio Curzio for having taken the initiative of installing this partnership between the Balzan Foundation, the Swiss Academies of Arts and Sciences and the Accademia dei Lincei, which hosts our fora when the Balzan Awards Ceremony is held in Rome. I am confident this partnership will continue to flourish, enriching the already strong relationship between Italy and Switzerland, and significantly contributing to interdisciplinary and international dialogue.

We will deal in today's Forum with the topic of specialization within a single discipline and how this can be reconciled with the requirement also to maintain a broader perspective and a recognition of where one's own research fits into the greater whole. There is certainly tension in our intellectual landscape between 'polymaths' and 'experts' in contemporary scholarship. I am very much looking forward to hearing our distinguished panel's opinions.

I would like to hand over now to Professor Salvatore Califano, who will chair the first session devoted to the sciences.

Session I

Salvatore Califano, Member of the Accademia Nazionale dei Lincei

For the time being I have the very simple job of introducing Professor Enric Banda who shall in turn introduce the first speaker, Professor Lambeck. Professor Banda is Research Professor of Geophysics at the Institute of Earth Sciences in Barcelona, Spanish Council for Scientific Research, former Secretary General of the European Science Foundation in Strasbourg, President of Euroscience in Strasbourg and Vice-Chairman of the Balzan General Prize Committee. Please, Vice-Chairman Banda it is now your turn to present Professor Kurt Lambeck.

Presentation of Kurt Lambeck, 2012 Balzan Prize for Solid Earth Sciences, with emphasis on interdisciplinary research

Enric Banda

Thank you, Chairman Califano, Prizewinners, distinguished guests, friends, colleagues. I have an easy task today, which is to introduce the 2012 Balzan Prizewinner for Solid Earth Sciences. When the committee discussed the nature of the Prize, we were clear on the subject of Solid Earth Sciences, but we also insisted on emphasising the interdisciplinary aspect. In our internal discussions this was determined to be a combination of geophysics, geology, geochemistry and geodesy, which in principle are the four pillars of Solid Earth Sciences. Having looked in detail at the curriculum of Professor Kurt Lambeck and after having heard him yesterday speaking at the awards ceremony, I think that there is little doubt that Kurt Lambeck substantially exceeds this requirement. If the committee was set on that particular combination, Professor Lambeck has added even more to the mix during his career: incorporating the work of oceanographers, atmospheric scientists, mathematicians, computer specialists, archaeologists and pre-historians. As you can see we were a little lacking in our ambition. Kurt Lambeck is an exceptional exponent of interdisciplinarity.

I can also say that Kurt Lambeck has contributed to a better understanding of how the Earth works. Allow me just to comment on one subject that the committee believed was crucial, the relation between sea level changes, Earth rebound (isostatic adjustment) and ice volumes. This is quite a wide subject. I take particular pleasure in presenting him, as I am an Earth scientist myself, though I have never become too involved in this particular area because Kurt Lambeck was already so far ahead and I did not dare challenge him. So I followed a different path in the field of Earth Sciences.

Let me explain what he has done in this field, using three particular entry points. I will keep these simplified and Kurt Lambeck, I expect you to correct me here if I err. In the first instance, the redistribution of mass from ice sheets and glaciers to oceans, produces small changes in the orientation of the rotation axis of the Earth. These changes today are measurable with geodetic techniques. Explaining the response of the Earth inspired him to write seminal papers and also a book, *The Earth's Variable Rotation*, which is today a classic. It was the first step, a very necessary step in obtaining meaningful results in this field. Secondly, Kurt Lambeck has in particular studied sea level changes as the result of ice melting and the associated isostatic compensation due to differential loading of the Earth crust. Put simply, if you load something, and the rigidity is not infinite, it deforms and when you unload, it deforms again. In relation to the Earth this is a very complex process. He has very rigorously studied the last glacial cycle and its consequences on sea level changes, ice cap evolution and the response of the viscous mantle, which is the part of the Earth between the base of the crust and the core. This has a tremendous impact in paleoclimatology and also in the prediction of sea level changes because the effects are not immediate. Thirdly, his studies have been crucial for measuring mantle viscosity. To many of you mantle viscosity does not mean much, but for an Earth scientist it means a lot because it is the single and most important parameter in studying the Earth's evolution, taken in a timescale of billions of years. The viscosity of the mantle actually controls the thermal convection of the mantle that drives plate tectonics, for instance, and thus the movement of the continents. So with these three points I have tried to illustrate the three most important elements that define his career. He has substantially contributed to both short term processes and also long term processes.

As a Balzan Prizewinner, Kurt Lambeck joins significant names in the Earth Sciences that have received the Balzan Prize. Those here with a background in the Earth Sciences would immediately recognize the names of Dan McKenzie, Drum Matthews, Frederick Vine, Freeman Gilbert and Xavier Le Pichon. I should also add here the names of those working in Atmospheric Physics and the Climate Sciences, like Wally Broecker or Claude Lorius who won the Balzan Prize a few years ago. One could say that this group of people has made a significant difference in our knowledge of the planet.

I will finish with a personal remark that I think is shared by many other scientists. Over the next few decades the global scientific community must take up the challenge of delivering the knowledge required to support efforts to achieve sustainable development in the context of global environmental change. In other words, we

need focused strategic solutions, employing interdisciplinary long-term research, to provide science-based support for actions to achieve sustainable development. Kurt Lambeck, by focusing his research on how the Earth actually functions, has already helped to offer solutions to anthropic effects, to risk analysis and how to overcome barriers to sustainability. I believe that the Balzan Foundation, by awarding a Prize to Kurt Lambeck, also contributes to a more sustainable world. Thank you very much.

Kurt Lambeck

A Dynamic Earth System

Thank you very much, Enric Banda, for your kind words. Listening to what you said, I think you gave a better account of some of the principles of geophysics than some of my students do. So you will certainly get a pass. I am deeply honoured, of course, to receive this award, the prestigious Balzan Prize, and I am particularly delighted by the opportunities that this is going to provide me to continue my work. Like many of us here in this room, I have been more or less forcibly retired, which means that you continue working, but you do not get paid any more. Your access to ready research funds sometimes gets cut off, so the Balzan Prize money comes at a very good time for me to be able to continue some of the work I believe is important, and in particular will enable me to pass on the little bit of knowledge I have gained to the next generation. Over the last twelve years or so, I have been very much handicapped by the foolishness of taking on other responsibilities, and I have not had as much communication with students as I normally would have had. I see this as an opportunity to rectify that and make amends for this oversight. The recognition by the Balzan Foundation of the importance of interdisciplinary research is very timely.

Earth Science is becoming increasingly complex and it is also becoming increasingly important as Enric Banda stated. Its complexity lies in the fact that it is largely an inverse problem that we are dealing with. We observe things in the field, on the surface of the Earth. We analyse phenomena in the laboratory and from that we try to understand the interior of the Earth. We try to understand the processes operating within the Earth and we try to understand the material properties of the Earth. So it is a huge complex inverse problem and, like most inverse problems, there is no unique solution, particularly if one stays within the limits of the conventional geophysical tools that we have. I believe, however, that it is only by looking for independent and new constraints from unexpected quarters that we can contribute to an effective solution to these massive inverse problems. One of the things I have tried to do over the years is to look for new insights, new pieces of information we can use.

The Earth is a very dynamic body, as anyone living in Italy will have experienced in their lifetime. The planet is constantly stressed by internal thermally driven processes that periodically manifest themselves at the surface by earthquakes and volcanic eruptions. These processes also lead to slow – imperceptible on the human time scale – change that has given the planet its present shape. We are also only too aware of the dynamic nature of the atmosphere and oceans, and together these internal and external forces of nature have shaped the planet as we observe it today.

Thus, we see a planet that is undergoing constant change. This is perhaps not what I expected when I started university in Australia in the late 1950s. There, and in subsequent post-graduate studies at the Technical University of Delft, the National Technical University of Athens, and Oxford University, I trained as a geodesist, as a ‘measurer of the Earth’, with the goal of determining the planet’s shape and gravity field using the then new methods provided by the tracking of artificial satellites. In those days, one was taught that the planet was basically fixed and that the occasional perturbations to the geodetic network were nuisances rather than a source of information on the planet’s response to the internal and external forces. That realisation, that the geodetic measurements could provide valuable insights into the dynamics of the Earth system, took another decade to be widely accepted, driven by both the growing geological evidence for the new ‘continental drift’ or plate tectonics, and by rapidly improving satellite tracking and spacecraft technologies.

Planetary gravity fields

My earliest years as a post-doctoral researcher were focused on understanding the Baker-Nunn camera network, which was the most important civilian global network for the scientific tracking of satellites. This was in the United States at the Smithsonian Astrophysical Observatory in Cambridge, which at that time was the leading centre for satellite geodesy studies. The satellite methods for positioning in those days, including the emerging ranging to satellites using lasers, were exceedingly cumbersome and imprecise compared with what is being achieved with lasers and GPS today, but they produced the fundamental theory for orbital motions that still forms the core of today’s activities. My own contribution to this was to improve the positioning methods using the so-called ‘geometrical method’ which avoided the need for any information on the orbital dynamics. This was important at the time because both the knowledge of the forces acting on the satellite

and the computational capabilities were limited. At the same time (late 1960s) my then colleague, E.M. Gaposchkin, had honed his skills at orbit analyses for gravity perturbations, and this yielded as a by-product additional estimates for tracking station coordinates. By combining the geometric and ‘dynamic’ methods and by incorporating terrestrial information on the gravity field – the foundations for which had been laid down earlier by W.M. Kaula – we were able to produce a global solution (the Smithsonian Standard Earth Model SE-II) that for the first time had significant geophysical implications: that the variations in gravity as seen near the planet’s surface were closely related to the then emerging plate tectonics hypothesis. With time, the plate tectonics model provided the underpinning of modern understanding of the evolution of the Earth, and I note that this was recognized on two occasions by the Balzan Foundation: with awards to D.P. McKenzie, D.H. Matthews and F.J. Vine in 1981 and to X. Le Pichon in 2002.

What made our work particularly significant was that at that time virtually every geological and geophysical observation had gone into constructing the hypothesis, and there were few independent measurements that could be used to test it. Our gravity model provided one of the more important ones for that. Gravity was anomalously high over the convergent plate boundaries – most notably around the Pacific – as well as over ‘hotspots’ or mantle plumes such as the Azores or Kerguelen; gravity was anomalously low over the older ocean basins and over old continental cratons. These correlations have been refined in subsequent work, but for the next decade or so our SE-II provided a key constraint in the modelling of mantle convection and subduction processes. And at the same time, the model achieved its original goals of becoming widely used by NASA and other space agencies for the orbit computation and prediction of a wide range of satellites.

I would summarize my own contribution to this model as having come from a good understanding of the accuracies of the observational data and the integration of different and distinctly different data so as to take account of the strengths and weaknesses of the individual contributions. The procedures we developed remained standards for the next decade or so and if the numerical results have now been superseded by newer space techniques and improved computational methods, all the essential long wavelength features of the planet’s gravity field established then remain valid today. For me, the importance of my work was two-fold: one, to learn the value of understanding one’s observational data base and the value of combining complementary data – sometimes from unexpected quarters – and two, that it was to lead me down a new path of geophysics.

The Earth's deformation spectrum

The new SE-II solution also provided a civilian global coordinate reference frame that allowed continental geodetic data to be interconnected and that provided a starting point for measuring the 'drift' of continents. Geodetic accuracies at that time had improved by about an order of magnitude, from a few tens of meters in 1960 to a few meters in 1970 – still too low for observing these drifts on decadal time scales. But major improvements in tracking accuracies were occurring – particularly, laser ranging and the electronic (Doppler) tracking systems, which had been the domain primarily of the US Navy – and were becoming increasingly accessible to civilian users. Also, new methods were being explored for sensing the gravity field with satellite-borne instrumentation (radar altimeters, gravity gradiometers, and others), and computational methods and capacity was expanding rapidly. Thus, by about 1970, I could be quite confident that within a few decades we would be able to observe the Earth's deformations at the centimetre level and that satellite geodesy would move from predominantly measuring the static Earth to monitoring the planet's dynamics. This was a good time to focus on what could be done with the emerging geodetic data, and I did that by moving to France to contribute to their growing satellite geodesy program, first at the Paris Observatory and later at the Institut de Physique du Globe and the University of Paris.

The spectrum of deformations of the Earth can be described in terms of time and length scales and observed, in principle at least, using a wide range of methods and disciplines. At the very long time scales, we have the tectonic plate motions on continental scales and the plate-margin deformations on more regional scales. On time scales of a few thousand years, we have the response of the Earth's surface and oceans to the deglaciation of the last large ice sheets. On annual and decadal scales, we have the Earth's response to atmospheric and ocean mass redistributions and possibly to changes in the core's magnetic field. On monthly to semidiurnal periods, we have the tidal deformations of the planet, and on time scales of hours to seconds, we have the displacement fields associated with the earthquake stress cycle. Geological data provides most of the insight for the longer period phenomena while seismological data provides the insights at the very short period part of the spectrum. One problem in understanding this spectrum was, and still is, to understand the transition from essentially elastic and brittle behaviour of the crust and mantle at the one end to the essentially fluid behaviour of the mantle at the other. The geodetic data, at least partly, fills the gap in between.

Thus, my goal circa 1970 was to examine each of these processes operating on

different time and length scales, and to arrive at a comprehensive understanding of the rheology of the planet such that one could begin to understand the response of the planet to any forcing. Grandiose plans are sure to fail. This one has, but much has been learnt on the journey!

Global scales: Planetary rotation and tides

One example of the global-scale processes was the Earth's rotation. The periodic tidal force deforms the planet and modifies the inertia tensor such that the rotation rate will vary with fortnightly, monthly, semi-annual and longer periods. Thus, measurements of these changes – and the improving satellite tracking methods also led to improvements in the planetary rotation measurements – should provide estimates of the Earth's rheological response at these periods. Does the Earth, for example, lag the tide-raising potential and therefore show evidence for energy dissipation at these periods? But other processes contribute to the changes in the Earth's rotation. These include cyclic changes in the atmospheric angular momentum and ocean tides, and the observations often tell us more about the fluid regimes than about the solid Earth. What I, along with my colleague A. Cazenave, was able to do, was to demonstrate that a very large part of the semi-annual and almost all of the annual changes in rotation were the result of the exchange of angular momentum between the solid Earth and the atmosphere over a wide range of periods, from a few days – at the then resolution of the data – to years. This has led to an ongoing program by others of calculating the atmospheric angular momentum from meteorological data and to strip this from the rotation data so that it becomes possible to examine the other contributions: is there a lag in the ocean tidal response or is any residual component the result of tidal energy dissipation in the mantle? The jury is still out, but certainly with the vastly improved data sets now available, both meteorological and geodetic, the problem is worth revisiting.

Tides perturb not only the Earth's rotation. Satellite motion is also affected by the associated gravitational changes and in 1974, in collaboration with G. Balmino and A. Cazenave, we developed a comprehensive orbital theory for the solid Earth effects, ocean and atmospheric tides. One important side effect of this was the realisation that the orbital perturbation provided a direct estimate of the amount of energy dissipated in the oceans during a tidal cycle, without requiring a knowledge of the specific dissipation mechanisms. Thus, these satellite estimates provide a powerful constraint on numerical models of tides, but, more interestingly, they provide a constraint on the evolution of the lunar orbit: from the analysis of artificial satellite orbital perturbations we were able to quantify the distancing of the Moon from the Earth at a rate of a

few cm/year. By identifying the major energy sink as being in the oceans, the extrapolation of the orbital evolution becomes uncertain because of the different and largely unknown changing ocean basin configurations back through time. This effectively solved the so-called ‘time-scale’ problem such that the orbit evolution was consistent with the Moon having formed in a close-Earth environment at about the same time as the Earth itself.

I have recently returned to the question of reconstructing the ocean basins through the recent glacial cycles and looking at the changes in tidal dissipation and its consequences on the long-term evolution of the Earth-Moon system. Hopefully, there will be some new results before I finally retire.

There are many other components in the spectrum of the Earth’s variable rotation, occurring over a wide range of time scales and which provide insight into the dynamics and interactions within the Earth-ocean-atmosphere system. Their examination took me on a journey – in the footsteps of W.H. Munk and G.J.F. MacDonald – through palaeontology to unravel the length of day in Palaeozoic time, through discussions of archaeological and historical records in search of lunar observations, and from earliest astronomical to modern geodetic observations. This was discussed in my 1980 book, *The Earth’s Variable Rotation*. Since 1980, the observational database has expanded considerably, and the noise spectrum has been much reduced such that new signals are appearing and a new review of the subject would be appropriate.

Regional scales: Lithospheric tectonics

In late 1977 I had returned to Australia to take up the position of Professor of Geophysics at the Australian National University (ANU), with an option of spending six months a year in France or the USA to pursue the space science component of my research. But that quickly proved impractical and I focused increasingly on tectonic processes acting in the Earth’s crust and upper mantle, focusing on the shorter wavelength and longer time part of the Earth-deformation spectrum. Initially this was through integrating the results of satellite altimetry analyses with geological and geophysical evidence to study the mechanisms by which seamounts – and other large volcanic complexes – were supported by the lithosphere (the outer layer of the planet capable of supporting stress differences on geological time scales). This was another case of where the geodetic results pointed to an interesting problem, but where they provided insights – on the strength of the oceanic lithosphere and on the evolution of the stress state, for example – only when this information was combined with other geophysical and geological information.

These studies led to a search for examples where one could infer the strength of the continental lithosphere over different time scales using gravity observations. The Australian continent provides several such examples. Australia is mostly an ancient continent, well eroded with little topographic relief and well away from active plate boundaries. But it contains large and deep sedimentary basins that are essentially inconsistent with then geophysical conventions: they are not in isostatic equilibrium in any conventional sense and they did not form through extension of the lithosphere. Clearly new models of these intra-continental sedimentary basins were required, and I was able to do this by introducing horizontal in-plane compressive driving stress, erosion and sedimentation as amplifiers of the deformation, and stress relaxation in the lithosphere, which involved deformation within the entire crust and upper mantle. The origins of this model is in the 1958 book by W.A. Heiskanen and F.A. Vening Meinesz – for me an influential book from my undergraduate days but that had been very much ignored by students through the following decades. I was able to test it in the mid-1980s with some novel seismic experiments. At the time the principal success of the models was probably in uniting the geological community against it, leading to a renewed interest in the geological evolution and to new deep crustal seismic sounding. It is fair to add that the then novel aspects of the proposed basin formation process have found their way into most modern models of continental tectonics.

Solid-fluid interactions: Sea level and ice sheets

1988 saw the publication of my second book, *Geophysical Geodesy* published by Oxford University Press. This was an attempt to convince the geodetic community to think of their experiments as one part of a much larger experiment of trying to understand the structure and evolution of the planet and of the importance of integrating the methods of conventional and satellite geodesy with geophysics, geology and the physics of the fluid regimes. This was a time when the technological advances of the earlier years were finally beginning to produce quantum leaps in accuracy and resolution of the geodetic measurements: the GPS system was in its development phase and rapid positioning at centimetre precisions was becoming a reality; the radio-astronomy tool of long-baseline interferometry had provided direct evidence for the motions of continents; the power of satellite altimetry for both geodesy and oceanography had been clearly demonstrated by the SEASAT satellite; and proto-types of the sensors that would revolutionize the ability to measure the Earth's gravity field had been flown and tested.

Upon reflection, it may appear odd to leave such a promising field at that time, and I have no real explanation for doing so other than that I saw other interesting sci-

ence problems that I thought I could contribute to. This included the question of sea level change during glacial cycles: the deformation of the Earth and the concomitant rise and fall of sea level on millennium time scales, stressing the planet cyclically with load stresses of several tens of MPa that are similar to the stress differences associated with mantle convection. In starting out, I was particularly fortunate to have had the very important inputs from two colleagues, M. Nakiboglu and M. Nakada, to formulate the mathematical methodology, as well as from subsequent students and researchers to carry out field, laboratory and computational work.

The ‘glacial rebound’ phenomenon is about the response of the Earth to the changing ice loads as the planet oscillates between glacial and interglacial periods. This response includes sea level change as water is taken out of (or added to) the oceans when ice sheets grow (or decay) – there is a rich geological record of such change extending back through several cycles – as well as an instrumental record for the past 100 or so years. The observational record also includes the surface deformation in response to the changing load stresses and this has now been observed directly for the past decade or two using geodetic positioning methods. Then there is the change in the gravity field as surface ice-water mass is redistributed and the Earth deforms. This results in further perturbations in the motions of close-Earth satellites as well as in the planet’s rotation. Different observational responses are sensitive to different parameters quantifying the rebound theory, and it is a field where interdisciplinarity is an absolute necessity if any progress is to be made.

The initial idea was to invert the observations of the response to estimate the mantle viscosity in the part of the spectrum between geodetic and geological frequencies. But, as always, the problem turned out to be more complex and the results were only as good as the *a priori* assumptions made about the glacial load history, uncertainties that were almost as large, if not larger, as those in the *a priori* knowledge of the mantle viscosity, and it was quickly learned that the focus had to be on improving the understanding of ice sheets as well.

The most important observational data set for glacial rebound comes from the geological record over time scales similar to that of the glacial cycles. This takes the form, for example, of the position of an old shoreline relative to the present shoreline. Thus, it is a relative measurement and an elevated shoreline could mean that there has been a reduction of water in the oceans, that the land has been uplifted, or both. On a deformable Earth, the response to the growth and decay of ice sheets results in a complex spatial pattern of sea level change because of the changes to both the shape of the planet’s surface and its gravity field. There will be places where at any time relative sea level is seen to be falling while elsewhere it is seen to be rising at rates

that are dependent on the mantle rheology and on the ice history – where the ice was, when it was there, and how much there was. A reasonable assumption is that we know when and where the ice sheets occurred, at least for the time since the last maximum glaciation. But there are no direct (or very few) observational constraints on the ice thickness through time. Thus, the scientific challenge is, from incomplete and imperfect data sets, to infer both the Earth response function and the ice sheet thickness, assuming that the history of the ice margins is known.

In principle this is a quite standard inverse formulation, but its execution has been fraught with difficulties. However, it is worth pursuing because, if it can be solved, it provides the best evidence we can have for the mantle properties that control mantle convection and the thermal evolution of the planet; because it would provide insights into the palaeo-ice sheets and climate; and because it would provide the background signals to present day sea level change. The geological and geomorphological records of central Scandinavia or northern Canada around the Hudson Bay point to ongoing land uplift (or local sea level fall) in response to the removal of the ice load. But elsewhere the ocean floor is loaded by the meltwater: the sea floor subsides, dragging the coastlines down with it. The rebound process is a global phenomenon that continues today and into the future even if no further changes were to occur in the remaining ice sheets. As we recognized early on, in 1984, modern sea level rise cannot be summarised by a single number of rise or fall and, like its palaeo counterpart, it will exhibit spatial variability.

Our approach to analysing the geological evidence has been to focus on regional solutions with a careful analysis of available field data and, where necessary, to complement existing information with new data. This has taken my students, colleagues, and, not often enough myself, to many parts of the world where the sea level response was expected to be particularly sensitive to certain ice or Earth parameters, including across Scandinavia, Greenland, the Mediterranean, several locations in Australia, Antarctica and most recently the Seychelles. This has been a slow process, but has enabled us to develop inversion schemes of field data that permitted the largely unknown mantle viscosity to be determined despite the only partial knowledge of the past ice sheets. Thus, we concluded that the mantle viscosity increased substantially with depth (by a factor of 20-50 between the average values for the upper and lower mantles). This is now widely accepted and has important consequences for modelling mantle convection. More challenging has been the determination of lateral variations in mantle viscosity, and we have made some progress down this path by focusing on regional solutions rather than attempting a single global solution. The lateral variation in the average upper mantle viscosity that we infer, is less than a factor of ten, higher

for the mantle beneath the ancient continents than for the mantle beneath the young oceanic lithosphere. This is less than we expected from *a priori* considerations of laboratory-based flow laws and lateral temperature variations inferred from surface heat-flow measurements, and we do not yet have a satisfactory explanation.

The other significant result that we established early on, in 1988, was that the Antarctica ice sheet has experienced a major reduction in volume (possibly as much as 20-25% of its volume) since the onset of the global deglaciation starting about 20,000 years ago. This was reached in an iterative process, first by analysing sea level data from locations far from former ice sheets to estimate the global change in ice volume, and then subtracting from this ice volume estimates from local inversions for individual northern hemisphere ice sheets, where the ice margin retreat is relatively well understood and where there is a reliable data base. We are now completing one further iteration in this process, but the essential conclusions about the Antarctic ice sheet are seemingly inescapable even though glaciologists may not like them: that the Antarctic ice sheet was substantially larger at the time of the last glacial maximum, extending out to the shelf edge in most locations; that melting occurred after that of the northern hemisphere ice sheets; and there was ongoing melting until at least 2000-3000 years ago.

Our inversions on the northern hemisphere ice sheets have included, in chronological order, the British Isles, Scandinavia and arctic Eurasia, Greenland and North America. These models are for the time since the last glacial maximum except for Eurasia, where we have been able to extend the inversions back to the penultimate glacial maximum about 140,000 years ago, and including the onset of the last glacial cycle starting at ~115,000 years ago. The significance of the model results is that they are free of glaciological and climate assumptions so that they provide independent models for testing the driving forces of climate, or for testing feedbacks between climate and ocean circulation. This is an area ripe for speculations: for example, to initiate ice sheet growth in arctic Russia at the start of the last glacial cycle, is global warming first required to disrupt the polar sea ice so as to produce atmospheric moisture in high and cold latitudes where currently precipitation is low? Are we beginning to see this today, with unseasonably late snow falls over northern Europe? This is also an area where much more work is required before we can give much credence to such speculations.

As I have noted earlier, one of the features of our work has been the search for new data types. One example of this comes from the nearby fish tanks along the Tyrrhenian coast of Italy (and elsewhere in the Mediterranean) constructed primarily during the Augustan period of the Roman Empire. I was led to these archaeological features

by my two colleagues M. Anzidei (INGV) and F. Antonioli (ENEA) who, following a pioneering effort by M. Caputo (La Sapienza) several decades earlier, realized that these structures were no longer functional because of local sea level rise. What we were able to contribute through our glacial rebound modelling and assessment of tectonic contributions, was the conversion of these local observations to global inferences of sea level change over the past 2000 years. Then, by comparing these results with recent tide gauge records from nearby sites, we were able to infer that the rise observed by the latter for about the last 100 years was in fact a recent phenomenon, and that from ~2000 to ~100 years ago there had been little net change in ocean volume. While this does not identify the source of the most recent change in ocean volume, its coincidence with the onset of global industrialisation does point to an anthropogenic influence. We are now in the process of expanding our fish tank studies to other parts of the Mediterranean to establish a regional baseline for sea level 2000 years ago, which can be used for separating the background geological contributions to sea level from the more recent human-driven contributions, for evaluating tectonic stability of the coastlines, and to provide an understanding of the functionality of other archaeological structures whose positions were controlled in some way by the sea level at the time of construction.

Whereto from here?

Humans have been aware of, and adjusted to, sea level change throughout their existence. There have been times when coastal dwellers would have had to shift their camps regularly, either to avoid inundation as in the Persian Gulf before c. 7000 years ago, or to move closer to the shore as in Scandinavia. Migratory routes will have been closed off and ocean crossings will have become wider and more dangerous. The development of successful models for sea level change through time does permit these changes to be quantified and hypotheses of human migrations to be tested. Could the fragmentation of a large near-shore island in the Aegean into the present archipelago that occurred around 10,000 BC and at a time of rapid sea level rise be the origin of the Atlantis myth? Are the struggles of the Sumerian God Enki with the sea and the subsequent deluge an early explanation for the inundation of the Persian Gulf at a similar time? It would require an extraordinarily long collective memory! Further back in time, were there periods before the last glacial maximum when the Red Sea did not impose a major barrier to human movement out of Africa? These are questions where the physical and social sciences meet and that we have started to address quantitatively.

In summarizing some of my work, over more years than I wish to count, I have identified many loose ends and I have not achieved my goal of developing that elusive model for the Earth's rheology to explain the response of the planet at all time and length scales. But in that journey we have identified many of the issues that need to be addressed by the next generation of researchers. I anticipate that the Balzan Prize will make a contribution to that.

Comments and Questions

Salvatore Califano

In posing my question, I will take my cue from one of the Lincei's most renowned members, Galileo Galilei, and follow an approach that would certainly appeal to him if he were here. My question concerns the effect of the action at a distance on the forces acting on the ground, either at a first order level in giving rise to the tides or even at high order level in producing more complex effects on a monthly time scale or even on semi-annual or longer periods. Galileo never believed in gravitational forces in their fundamental form as described by Newton; not even Newton actually believed in calling them forces. Many great physicists, such as Leibnitz, Ørsted and Descartes, disagreed with Newton's original idea of the existence of an action at a distance. It is only very recently, since the development of Einstein's gravitational theory, that we have reached the conclusion that the deformation of the space-time surface introduces a deformation of the geodetics which gives rise to what we call the attraction between masses. Now, the question that Galileo might have asked is: are these forces in part a consequence of the shift along the geodetics, in other words, are they in part also kinematic effects which Galileo would have envisaged in terms of the rise in sea level?

Kurt Lambeck

I think the reason that I am standing here – having been awarded the Balzan Prize for geophysics – is that I wasn't smart enough at university to do theoretical physics. I cannot even begin to try and answer your question, I am afraid. I should perhaps say that my background is that of an engineer. My first degree was in engineering, but I soon realized that I had made a mistake and decided to do science. It has had one consequence, and that is that it has always given me a very pragmatic approach in doing my science. We observe things, we develop an hypothesis, test the hypothesis and if it works we possibly do not question the underlying implications of the process beyond our geophysics. I am not sure I understood your comment about the tides. I

know there is a whole literature on the interpretation of the tides and I cannot really give a lecture on how the tides work here. It is a very complicated process; it is not simply the surface being lifted up.

Salvatore Califano

The same effect extends also in the long run, as secondary or tertiary effects that are then preserved in a process similar to epigenetic changes in the structure of the Earth. As you have said, Humans have adjusted to sea level change throughout their existence as shown by the fact that coastal dwellers would have had to shift their camps regularly, either to avoid inundations or to move closer to the shore.

Kurt Lambeck

The Earth time constants are typically of the order of thousands of years to a hundred million years. They are controlled by the strength of the lithosphere and the viscosity of the mantle. The viscosity of the mantle is typically 10^{21} Pascal seconds, which means that after twenty/thirty thousand years the Earth has lost any memory of earlier events. So it is difficult to take our present day information and extrapolate it too far back in time. Now the upper part of the Earth has a better memory in terms of the geological record. There it goes much further back, but that record is also much more complicated, because it is a constant overprinting of different phenomena, and the further back in time you go the more complex it becomes.

Salvatore Califano

One of the basic problems of modern physics can be distilled into the question: are the gravitational constants really constant at any order or not?

Kurt Lambeck

The question of whether the gravitational constants change with time is one that we have been interested in, certainly. If you look at the Earth's rotation carefully over a long period, we know that the Earth is slowing down. Now a large part of that is caused by tidal friction, the dissipation of energy in the ocean tides. There is always a remaining few percent that we cannot explain. Either it is within the uncertainty of our analysis or there may be some other process going on. The trouble is that there are several contenders for this scenario. One is electromagnetic coupling between the core and the mantle and the other is a change in the gravitational constant. At this stage we cannot be categorical and say it is one or the other.

Salvatore Califano

Thank you very much Professor Lambeck.

The next Balzan Prizewinner is Charles Baulcombe who will be presented by Marc Van Montagu, Professor Emeritus of Molecular Genetics at Ghent University, Chairman of the Institute of Plant Biotechnology Outreach (IPBO), Ghent, and member of the Balzan General Prize Committee.

Please, Professor Van Montagu.

Presentation of David Baulcombe, 2012 Balzan Prize for Epigenetics

Marc Van Montagu

Good afternoon. It is a very great pleasure to introduce the Balzan Prizewinner for Epigenetics, Professor David Baulcombe. Progress in the life sciences is closely linked with the techniques we use to analyse and study different phenomena. The improvement in techniques and the hard work devoted to assembling the data is extremely important. We are all fascinated by the life sciences. We have brilliant minds who work in this field. They can be beguiled by the technology and forget to synthesize actual knowledge from the data they have collated. This can be an issue. Those that create general theories without firm data cause problems, too. This is the background you have to keep in mind when speaking about the life sciences.

The subject we are dealing with here, epigenetics, is of utmost importance in the life sciences, but also in sociology and within society in general. We just have to remember when the brilliant observations of Darwin were originally communicated and people tried to understand the implications, including the rediscovery of the laws of Mendel, the whole issue of genetics fascinated society. All kinds of conclusions were put forward and we had the duality between nature and nurture, and we did not really know how to solve that issue. Many in society said that everything was connected to genes. We had the theory of the static genome with the proposition that we had good genes and bad genes and better genes. So there must be superior genomes, superior races. Then the real drama occurred. Racism entered the picture. People believed they were speaking rationally. So this is obviously a very important subject.

Those scientists that are keen observers noticed that not only did mutations change the genome, but that at certain moments, properties seemed to be selected rapidly through certain stress events. The problem was how to accurately describe what was going on. As the concept that DNA was the molecular base of heredity was gradually established, scientists then began studying genomes, and it should be remembered

that it is only very recently that it was established that genomes are not static. They are indeed enormously dynamic and indeed are always changing. This also produces another problem that affects society, because today in the context of the need for more sustainable agriculture, some scientists are trying to convince us that we need new types of plants which traditional breeding methods cannot produce quickly enough, so genetic engineering should be used to produce these. The average person fears genetic engineering, because they still live in the era of the constant genome, believing that it should not be tampered with.

There is a duality concerning the facts and ideology apparent in recent developments. In the last decade much progress has been made in describing DNA in chromatin, where the DNA is bound around histone proteins forming nucleosomes. These actions are all programmed; they are not random processes. This again opens up a whole other world. Some traditional molecular biologists do not like the term epigenetics. They say it is just a problem of gene regulation programming. This is an issue of semantics. Words can become restricting, and I am convinced that epigenetics is a phenomena that is already well proven in describing changes that are not linked to mutations, that are more than the expression of gene regulation.

Going back to one of my first points, David Baulcombe has carried out groundbreaking research and established the importance of the small RNA molecules that are the basis of alterations that occur in the cell, changes that are epigenetic. We should note, however, that the term is used by many to describe changes that have not been fully investigated yet. In neurobiology regarding behaviour, it is clear that events and nurture affect this. For example, if someone believes in religion, is it really because of some event that occurred earlier in life? We are still a long way off from considering such a situation as epigenetic. In regard to cancer, it is not just mutations that cause deregulation of the cell, but also stresses which cause proliferation and the cell remains in this changed state. If we can effectively analyse this process we will achieve significant success. How RNA is involved in detail is what David Baulcombe will explain now.

David Baulcombe

RNA Silencing and Epigenetics

Ladies and gentlemen, good afternoon. I have already said and I will be happy to say again how much of an honour and a privilege it is to receive the 2012 Balzan Prize for Epigenetics. I have to say that honour has a silver lining to it, which is the real privilege of talking this afternoon in this remarkable building which is a shrine to

the independence of science from political interference, standing here under the figure of Galileo himself.

What I would like to do this afternoon is to make two points. The first point is about connections within natural sciences and how it is very difficult to compartmentalize different branches of natural science, and also to make a point that beyond the natural sciences, or natural philosophy as one might call them, there is a connection with moral philosophy. I will try and draw out that connection as I go through my presentation. The second point I would like to make is about the process of scientific discovery and how it is not a smooth and predictable path, how there are elements of surprise and serendipity, which play a key role in such a process. In the context of structuring society so that science can make the greatest progress, we need to allow for the opportunity for unexpected results and serendipitous discoveries. Certainly I have been able to benefit from that in my science career.

First, I should explain what I mean by ‘RNA silencing’ and ‘epigenetics’, because they are rather specialised terms and they may seem rather obscure even to the learned and well read attendees at an Interdisciplinary Forum of the Balzan Foundation. However, before I start, I should make a confession. It is that I did not start my research career with a grand vision. I knew that I wanted to work on genes and the regulation of their expression, because I thought it was one of the most important topics in biology, but I did not have a clear view as to how to proceed. I am here because of chance, lucky breaks and because I have a slightly belligerent streak that leads me away from the mainstream. You can already see that I am not a dedicated follower of sartorial fashion and the same applies with science fashion. I hope you find some interest in this description of my scientific ramblings in which I try to persuade you that our findings with plants raise important questions about the blurred distinction between nature and nurture in general biology.

RNA silencing

I will start with ‘RNA silencing’, because it was my way into epigenetics. RNA silencing inactivates gene expression through processes acting at the level of RNA rather than DNA. My work on RNA silencing began when I had the good fortune in the 1980s to work with Mike Bevan, who is one of the pioneers of transgenic plants. At that time my interests were in plant viruses and, for various reasons, transgenic plants expressing viral genes were useful. Some of our experiments were designed to generate virus-resistant transgenic plants using a type of genetic immunisation

strategy. The aim was to find out about the mechanism of virus replication and to produce genetically modified crops that would be protected against virus disease.

Like many early users of transgene technology in plants, we observed that some transgenic lines expressed the transgene and others did not. This variation was expected. However, there was a rather puzzling anomaly in that the virus-resistant lines were those in which the transgene was silent: if the transgene was expressed at a high level, the lines were fully susceptible. This finding was unlike more straightforward situations in which the phenotype of a gene would be associated with its expression. To reconcile our observations with common sense, we proposed that the virus resistance could be due to the same process that silenced the transgene.

The virus used in these experiments had an RNA genome. It replicated as RNA and it did not use DNA at all in its life cycle. Therefore, if the virus and transgene were suppressed by the same mechanism, it followed that the silencing mechanism did not require a DNA target. It would operate at the RNA level. I described these data in a seminar in Basel in the mid 1990s, when I referred to the effect as 'gene silencing'. Ingo Potrykus, who later hit the headlines with his work on golden rice, pointed out that 'gene silencing' was an inappropriate term. He suggested that 'RNA silencing' would be a better. I have followed his suggestion ever since, as have others.

Other reports appeared at about the same time, or shortly afterwards, indicating that RNA silencing also occurs in fungi and in animals including worms, flies and mammals. Most notably, Fire and Mello made the seminal discovery that RNA silencing could be initiated by double stranded RNA. They referred to their version of RNA silencing as RNA interference.

In my laboratory, we were interested in the specificity determinant rather than the initiator, because the transgenic virus resistance due to RNA silencing was always virus-specific. A transgene based on potato virus X, for example, could only confer resistance against potato virus X or indeed some strains of potato virus X, whereas a transgene based on potato virus Y was similarly specific to that virus. It seemed as if the transgenes conferred resistance in a manner that was specific to their nucleotide sequence – the order of the A, C, G and T residues.

Andrew Hamilton, others and I hypothesised that, to explain this sequence specificity, there had to be an RNA that would bind by Watson-Crick base pairing to the target RNA of silencing. This antisense RNA would be produced either directly or indirectly from the transgene. Andrew's first attempts to identify this molecule were not successful. However, we realised eventually that the hypothetical RNA is much smaller than we had expected and that his methods were not suitable.

Andrew then adapted his assay methods and, in several different experimental systems, he identified antisense RNAs corresponding to the target of RNA silencing that were about 25 nucleotides long. He later further resolved these RNAs into species of 21, 22 and 24nt in length. Similar RNAs were later implicated in RNA silencing in animals and fungi. The common presence of these short RNAs in different systems confirmed that the RNA interference of Fire and Mello, our work with plants and the experiments with other systems were all addressing a common process. The small RNAs were later named as small interfering (si)RNAs.

The details of RNA silencing emerged soon afterwards in what was one of the most rewarding periods of my career. My laboratory, using genetic screens in plants, provided information that was relevant to researchers in animals and *vice versa*. In just a few years, the global silencing community established a core mechanism of RNA silencing in plants and animals that is the basis of our current work.

Two of the most important discoveries, from the Hannon group, were the Dicer and Slicer proteins. Dicer was able to generate siRNAs from a long double stranded RNA precursor, and the Slicer protein is the effector of silencing that binds to the siRNA. The siRNA binds to target RNAs by Watson-Crick base pairing, and Slicer cleaves them so that, if they are a messenger RNA, they cannot be translated into protein.

The evolutionary origins of RNA silencing

Many types of eukaryote, including animals, plants, fungi and protozoans, have versions of RNA silencing. It is likely therefore that RNA silencing was active in a primitive unicellular eukaryotic cell. It may even have evolved earlier, during a phase of evolution known as the RNA world that existed before DNA acquired its key role in the genetic code and inheritance. In that scenario, the RNA silencing mechanism would have been lost in the evolutionary lineage leading to modern bacteria, because they do not use RNA silencing or have the main proteins in the core silencing pathway.

Primitive cells in which RNA silencing first evolved would have been good hosts for viruses, selfish DNA, and they would have needed defence systems. RNA silencing is an attractive candidate for such a primitive defence system because it can target the parasite without affecting the host. This property is achieved because the siRNA would be derived from the virus or selfish DNA and because the genome sequence of these parasites is distinct from the sequence of the host cell.

Modern plants and some animals including worms and insects have retained this defence role of RNA silencing. Plants that are mutant for Dicer or Slicer, for example,

are more sensitive than the wild type plants to virus disease. They are also less able than wild type plants to protect themselves against a type of selfish DNA that is able to transpose from one site to another in the genome. However, RNA silencing has diversified in the different plant and animal lineages since the evolutionary divergence of animals and plants, and it now has additional roles in different organisms. It regulates gene expression, for example, in many cells by targeting RNA degradation or by preventing its translation into protein. In some organisms it produces an RNA that moves between cells, or even – in plants – from the shoot to the root. It may also influence recombination between parental genomes during the production of eggs and sperm, and it has particular roles in genome regulation that are specific to some protozoans.

Epigenetics

To illustrate the diversification of RNA silencing, and to introduce epigenetics, I would like to describe experiments in which we modified viruses to carry parts of host genes. The aim of these experiments was to develop a system for analysis of gene function. The idea was based on our understanding, described above, that RNA silencing is part of a virus defence system. With an unmodified virus, the siRNAs correspond to the viral genome, and RNA silencing targets the virus rather than the host. However, if host sequence is introduced into the viral genome, the siRNAs now correspond to the virus and that host element. There is silencing of host RNA if the viral insert corresponds to a gene, and the symptoms on the infected plant resemble the appearance of a mutant in that gene. This system and its variations have been useful for cataloguing the function of many genes in plants and animals because it is relatively easy to carry out a survey of many thousands of genes.

In some experiments the virus-induced silencing of the host element persisted only for as long as the virus in the infected plant. However, in other instances, the silencing effect persisted for several generations. The virus was not transmitted between generations and the DNA sequence of the target gene was unaltered. These characteristics – persistence of effect through cell division and without genetic change – conform precisely to the definition of an epigenetic effect.

Other well known examples of epigenetic effects include vernalisation in plants and X chromosome inactivation in female mammals. Vernalisation occurs when young winter annual plants experience cold. The cold treatment results in epigenetic silencing of a floral repressor gene that normally prevents flowering. However, once that gene is epigenetically silenced, the plants are competent to respond to light, and they flower when the day length has lengthened in the following spring or summer.

X chromosome inactivation in mammals silences one of the two X chromosomes in female mammals. Once silenced, this chromosome remains inactive for the lifetime of the plant, although its DNA sequence does not change and it can be reactivated in the next generation progeny. X chromosome inactivation is important as a means of dosage compensation. It ensures that the X chromosome produces the same amount of protein in females with two copies and males with only one.

A hallmark of epigenetics is that there are separate establishment and maintenance phases. Establishment in the three examples given above is due, respectively, to the viral RNA, an effect of cold and an ill-defined trigger associated with early development. Maintenance is similarly diverse and can involve chemical modification of the DNA or of proteins associated with DNA. The RNA-directed silencing described above, for example, is dependent on methylation of DNA at the silenced locus, and our findings follow from the seminal discovery of Michael Wassenegger that RNA can direct DNA methylation in plants. This separation of establishment and maintenance is important, because it ensures that continued presence of the initiator is not required for persistence of the epigenetic effect.

DNA methylation is effective as a maintenance mechanism of RNA silencing for two reasons. First, it affects the proteins bound to the DNA and prevents the DNA from being transcribed into RNA. The second reason is because the pattern of DNA replication is stable from one generation to the next in the absence of the initiator RNA. The enzyme that adds methyl groups to the C residues of DNA can replicate the pattern of DNA methylation from the parental strands of the DNA onto the daughters.

Much of our work in recent years has been aimed at unravelling the mechanism of RNA-directed epigenetic modification in plants, and some of the progress involves details that will not be of interest in a general forum. However, I would like to refer briefly to four features of this molecular stamp collecting, because they are relevant to later points.

First, we have discovered that two atypical forms of the RNA polymerase are involved in epigenetic RNA silencing. One of these is thought to produce the precursor of siRNAs. The other, from findings of Craig Pikaard and colleagues, produces scaffold RNAs that are attached to their DNA template. These scaffold RNAs can be targeted directly by the siRNAs that are bound to Slicer proteins. The Slicer protein is then able to recruit the enzymes that introduce DNA methylation marks associated with epigenetic changes to the target region of the chromosome. This aspect of the mechanism is important because it explains how RNA can find a target in double stranded DNA.

A third discovery, by us and others, is of endogenous siRNAs with the potential to influence epigenetic features of the genome. Epigenetic RNA silencing, therefore, has effects that go beyond virus resistance. It is a constant and extensive background to the behaviour of the genome. A surprising fourth element of the silencing machinery is mobility between cells. The epigenetic siRNAs spread through the plant and mediate epigenetic modification of the genome in the recipient cells.

The understanding of RNA silencing mechanisms allows us to investigate the biological role of the RNA-directed epigenetic changes in plants. We are particularly interested, for example, to find out whether viruses and stress can induce siRNAs that then lead to epigenetic changes. Such a process could explain how plants can become acclimatised to different environments and some of our current projects are addressing that possibility.

In our recent work, we have become particularly interested in epigenetics and the effects of hybridisation between different species or varieties of plant. I hypothesised that siRNA from the genome of one parent of the hybrid could find novel targets in the second parental genome and induce epigenetic marks that are absent from the parents. These novel epigenetic marks could then be inherited between generations. The hybrid-specific marks could affect gene expression if they are in or adjacent to genes, and they would cause the heritable phenotype of hybrids to be outside the range of the parents. Such phenotypes are well known to plant breeders and they are referred to as transgressive. Our recent work on tomatoes is consistent with the proposed involvement of siRNA in silencing and it is taking us into new areas that may be relevant to evolution and to methods for crop plant improvement.

The findings are relevant to evolution because they imply a new consequence of hybridisation beyond the creation of gene combinations that do not exist in the parents. It would also be a process that generates new heritable variation. Following from this point, because modern organisms are the progeny of past hybridisation events, it follows that some of the heritable variation between varieties or species will be epigenetic rather than genetic.

There is, therefore, the potential for organisms to use hybrid-induced epigenetic variation to experiment with the effects of silencing a gene or set of genes. An epigenetic mutation conferring a fitness benefit would be selected for and eventually stabilized by genetic mutation. Conversely, it would be selected against if it has a deleterious effect or would revert to the original unmodified epigenetic condition.

My laboratory is testing the importance of hybrid-induced and other forms of epigenetic variation in evolution. To initiate this study, we will first explore the extent to which heritable phenotypic variation is due to epigenetics. We are using seed plants

including *Arabidopsis* and tomato. A green alga – *Chlamydomonas* – is also a useful system, because it has a rapid life cycle in liquid culture. We are planning to isolate mutants in the RNA silencing and epigenetic pathways so that we can explore their potential of these mechanisms to influence adaptation to modified environments. Plant breeders may also be interested in heritable epigenetic variation affecting key traits. They would have the opportunity to produce new varieties by selection for epigenetic as well as genetic markers.

Another practical application of RNA silencing and epigenetics is based on our discovery that epigenetic siRNAs are mobile in the plant. We are using this discovery to develop a novel strategy for crop improvement based on epigenetic rather than genetic modification.

The strategy requires first that a target gene is identified that has an adverse effect on a crop. It could be a gene affecting, for example, storage or processing quality of the crop. The next step is to produce a plant with epigenetic siRNA corresponding to this gene. The plant could be infected with a suitably modified virus or it could be a GM variety and it would be grafted as a stock onto the unmodified crop as a scion using methods that are standard horticultural practise.

Once the graft union is established, the epigenetic siRNA should spread across the graft union and mediate epigenetic silencing of the target gene in the crop. The silencing would be transient if the mobile siRNA were a standard genetic regulator. However, as this siRNA mediates epigenetic changes in the recipient tissue, we predict that the silencing effect would persist in these cuttings and their progeny.

These plants would be epigenetically rather than genetically modified, and I am interested to find out how well such plants perform in the field and whether they would require regulatory approval before they could be used as crops. If successful, this strategy could provide a useful additional tool for plant breeders and biotechnologists. It would have an advantage over genetic modification or conventional breeding in that the improvement could be introduced into multiple varieties with relative ease. It would be possible therefore to retain or even increase the diversity of varieties used in agriculture.

Epigenetics and animals including humans

I am a Professor of Botany, and so most of the examples given above are with plants. However, there are indications that some of these plant findings are relevant to animals, including humans. There are, for example, reports of environmentally induced and heritable epigenetic effects in humans. Study of a population in the north of Sweden indicates that body mass index or mortality risk ratio correlates with smoking

or diet in the grandparents. There are also indications in animals that RNA silencing and epigenetics are connected in germline and other cells through the action of small RNAs known as piRNAs.

I do not expect that there will be an exact parallel of epigenetic phenomena in plants and animals, because the underlying molecular mechanisms are likely to differ to some extent. However, it may well be that the human condition could be improved if we had answers to the following questions that are similar to those that we are addressing in our plant work:

- to what extent does the environment cause the epigenetic marks to change during animal development? Do stresses or chemicals induce epigenetic changes in adult or somatic stem cells that could have long lasting effects in behaviour or disease, including cancer? Such somatic epigenetic changes would not be transmitted to the next generation, but they nevertheless could have a profound effect on the health or well being of the organism;
- to what extent is heritable phenotypic variation between individuals determined by genetic and epigenetic factors? It has been difficult to link many characteristics, including behavioural differences, to genetic factors, and so heritable epigenetic variation should be assessed in large scale studies of that are at present used to assess the association of phenotype with genetic marks.

Both questions address the relationship between the nurture of an organism and, through stable epigenetic marks, its nature. In some instances, this could be an epigenetic nature that is inherited from one generation to the next. In other examples, the epigenetic effect, like vernalisation and X chromosome inactivation, could be reset during gamete formation of each generation. I hope that our work with plants might provide a guide at least to the research that will address these important questions.

Comments and Questions

Salvatore Califano

Did I understand correctly that epigenetics can work at different levels, i.e. that we can speak of a first order, a second order and higher order intervention of the small RNA molecules on proteins? If this is correct, what is the driving force that causes them to move and reach the right place in the gene? I thought in principle that it could be the concentration – indeed the flow of concentration – around specific size proteins controlled by salts, pieces of protein, residues and whatever, and the RNA has to find its way through all this. Is this the driving force which controls or conditions the arrival of the RNA at the right place?

David Baulcombe

Yes, Chairman, well, yes means that I am thinking about the response to your question. Firstly, Salvatore Califano, if I may, I would like to congratulate you. You are the first Chairman, indeed the first person, that I have ever heard who has managed to refer to the epigenetics of the Earth, which you did in relation to the previous discourse. That was highly original. So congratulations on that.

Secondly, in response to your question about layers and the driving force, I think you are asking if there is any direction to these processes. So should we be Lamarckian? Should we be thinking about giraffes feeding on taller trees and small RNAs being induced that will somehow affect the length of the neck of the little giraffes...?

Salvatore Califano

There is nothing bad in a Lamarckian approach.

David Baulcombe

There is nothing bad in it, but there is nothing necessarily good in it. Certainly, as things stand, there is no reason for us to adopt a Lamarckian approach. What we can think about in relation to the giraffe, is the stress or physiological changes induced by the giraffe leaning up to the higher leaves on the trees which could introduce changes to the spectrum of small RNA; perhaps in that giraffe that would then affect random heritable phenotypes. We can think of these processes as being a way that organisms experiment with heritable variation and how the epigenetic effect can anticipate the later and more permanent genetic effect.

Salvatore Califano

Thank you very much, David Baulcombe.

Session II

Karlheinz Stierle, Member of the Balzan General Prize Committee and Foreign Fellow of the Accademia Nazionale dei Lincei

Good afternoon, ladies and gentlemen. Now we will deal with an interdisciplinary field, which in the wider sense can be termed the humanities. We have two wonderful examples of what interdisciplinarity really means: in the first instance, Jurisprudence and Philosophy, and in the second, Musicology. These are exemplary subjects, indicating what interdisciplinarity can achieve.

I now have the pleasure to present the Chair of our Balzan Prize for Jurisprudence special committee, Professor Antonio Padoa Schioppa. He is Professor Emeritus of Legal History at the Università Statale in Milan. He is the former President of the Istituto Lombardo, Academy of Sciences and the Humanities, and a corresponding member of the Institut de France. I would now like to ask him to introduce our Prizewinner.

Presentation of Ronald Dworkin, 2012 Balzan Prize for Jurisprudence

Antonio Padoa Schioppa

Chairman, ladies and gentleman. Ronald Dworkin has achieved in the course of an academic career of more than thirty years a unique place among contemporary legal philosophers. His early seminal work, *Taking Rights Seriously*, published in 1977, presented new perspectives in relation to the most difficult questions then being debated in the field of Jurisprudence. These included the crucial relationship between rules and principles or the proper role of judges in interpreting the Constitution and the Bill of Rights. Later, an impressive body of published research has succeeded in widening the scope of legal theory to encompass the fundamental topics of ethics and political philosophy, analyzed in the context of law and jurisprudence. These works include: *Freedom's Law* (1996), *Sovereign Virtue* (2000), and most recently *Justice for Hedgehogs* (2011), a critical, historical and constructive analysis and synthesis of ancient and contemporary theories regarding values, brilliantly achieved by demonstrating the basic complementarity among them. The value of 'human dignity' clearly underlies both the principles of 'equal concern' and of 'personal responsibility', the two pillars of Dworkin's concept of legal values. From this perspective he develops an original theory concerning the relationship between equality and liberty, a classical problem in legal ethics.

Professor Dworkin conceives of law and morals as two distinct but strictly connected domains, particularly in relation to the difficult task of deciding cases. He has studied these connections in many of his works, including *Justice in Robes* (2006). The link between legal theories and concrete decisions is one of the reasons for the wide influence exerted by Ronald Dworkin's thought, far beyond the secluded world of legal philosophers. Throughout his writings, his outstanding analytical and argumentative abilities are clearly on display and alive in the passionate dialogue carried on with many eminent proponents of the various major contemporary legal theories, among them Hart, Rawls, Raz and Nozick. In the works conceived for a wider public, his style is always very clear and eminently readable, which is not the case with every philosopher. His elegant writing style is particularly apparent in *Law's Empire* (1986) and in his thoughtful and incisive reflections on American democracy and its critical aspects in *Is Democracy Possible Here?* published in 2006.

For these reasons, the committee has unanimously decided that Ronald Dworkin deserves to be acknowledged as one of the pre-eminent scholars in the field of contemporary legal thought.

Ronald Dworkin

Legal Theory from the Inside Out

Thank you for that excellent introduction, a great feat of mentioning everything I have ever written in a very brief synopsis. Our theme is interdisciplinarity and I am going to argue that law is the queen of interdisciplinarity. Law is at the cutting edge of many different disciplines and I am going and try to illustrate this point by talking about my own career, not because I believe that everything I think is right, but because my career has illustrated a marked trajectory from the very concrete to the very abstract.

My last book, *Justice for Hedgehogs*, offers a panorama of the work I have done over half a century: not just a survey but an integration, trying to explain how it all fits together. I will make this summary more chronological. I began my professional life as a young lawyer in a grand Wall Street law firm. My work could not have been more detailed and less abstract then. I wrote elaborate bond indentures and studied the balance sheets of giant corporations, helping them to satisfy the laws that allowed them to raise more money and grow greater still. Since then, in an academic career at several institutions, my interests have grown steadily more abstract. But in each case the intellectual pressure I felt developed from bottom up, not top down. I took up steadily

more abstract philosophical issues only because the more practical and political issues that first drew my attention seemed to me to demand a more philosophical approach to reach a satisfactory resolution. I will try to illustrate that process of philosophical ascent here.

When I left Wall Street to join a law school faculty, I took up a branch of law – constitutional law – that is in the United States of immediate and capital political importance. Our constitution sets out individual rights that it declares immune from government violation. That means that even a democratically elected parliament, representing a majority opinion, has no legal power to abridge the rights the Constitution declares. But it declares these individual rights in very abstract language, often in the language of abstract moral principle. It declares, for example, that government shall not deny the freedom of speech, or impose cruel punishments, or deprive anyone of life, liberty or property without due process or law, or of the equal protection of the law.

The Supreme Court has the final word on how these abstract clauses will be interpreted, and a great many of the most consequential political decisions taken in the United States over its history were decisions of that Court. The terrible Civil War was in part provoked by the Supreme Court's decision that slaves were property and had no constitutional rights; racial justice was severely damaged, after that war, by the Court's decision that racially segregated public schools and other facilities did not deny equal protection of the law; a good deal of Franklin Roosevelt's progressive economic legislation was declared unconstitutional because it invaded property rights and so denied due process. These were the bad decisions that everyone now regrets. There have been very good decisions, too: in 1954 the Court, reversing its earlier bad decision, declared that segregated schools were inherently unequal, and therefore did deny equal protection of the law.

It is therefore a crucial question how courts should interpret the abstract constitutional language: what makes a particular reading of that language correct or incorrect? But the constitution is law – it declares itself to be the most fundamental law – and so the question how it should be interpreted is really only one form of the ancient jurisprudential question: what is law? How should judges decide what the law of some nation really is on some particular subject? Over centuries philosophers have disagreed. In recent times one theory of law – it is called legal positivism – has been particularly influential. This declares that what the law is on some subject in no way depends on what the law ought to be. What the law is depends, according to positivism, not on morality, but only on history: on what people given the appropriate authority have declared it to be. We discover what the law on any subject is, according to positivism, by identifying those in authority and finding out what they have said.

In most cases this is a relatively easy matter. There are books that set out civil codes and record the other decisions of parliaments and the past rulings of judges. Lawyers know where these books are kept, and how to read them. But what if law-makers speak in abstract language and what they said can be read in different ways? The United States Constitution forbids ‘cruel’ punishments. Does the rule out capital punishment – the death penalty?

Two answers are open to legal positivists. They can say that since the ‘framers’ who made the Constitution did not say one way or the other, there is no law on the subject, and the Supreme Court is therefore free to make up its own mind. But that sounds profoundly undemocratic. Or a positivist can say that the answer depends on what the framers intended, or expected, or would have declared if they had thought of the question. In this case that strategy decides the issue. Since capital punishment was widely used in the United States in the early 18th century, when the ‘framers’ published their clause, they could not have intended or expected to declare it unconstitutional. Therefore it is not, even now, unconstitutional.

So it is of great practical consequence whether legal positivism is a sound philosophy of law; that is important not only in the United States but now in all the many other countries, including Italy, that subscribe to abstract constitutional rights. One cannot properly understand or participate in constitutional law without taking a stand on that subject. So I did. From the 1960s until the present, I have argued in a variety of books and articles that it is very much unsound. It provides only an incompetent description of the actual practice of law. Lawyers and judges typically make claims about what the law actually is, that cannot be thought to be grounded just in what authoritative bodies have previously declared. Even more fundamentally, legal positivism is based on severe misunderstandings in the philosophy of language. It assumes that we share the concept of law the way we share the concept of a triangle, that is, that we all agree on the tests to use to decide whether a legal claim is true or false. But we do not. For us, the concept of law – like other political concepts such as the concept of justice – is an *interpretive* concept: a theory of law is a normative claim about the tests that we *should* use to judge claims of law. A theory of law is a special kind of political theory, and so what law is cannot be separated completely from what it should be.

Once we reject positivism, however, we need another, different theory of law. In a series of articles and then in *Law’s Empire*, in 1986, I offered a theory. A claim of law should be understood as a claim about the best interpretation of past and contemporary legal and political practices in the nation in question. We need a theory of what interpretation is – about what counts as a successful interpretation – in order to fill out this interpretive theory. I proposed what I came to call a ‘value’ theory of interpreta-

tion. An interpretation must fit the data – it must fit the practices and history it claims to interpret – but it must also provide a justification for those practices. It must, as I sometimes put it, show the practice in its best light. The first requirement – of fit – is not enough on its own, because more than one interpretation of a complex set of legal data may fit well enough to count. The second requirement – of justification – is therefore crucial. It shows why positivism must fail as a general theory of law. We cannot identify law without assuming some justification, however weak, in political morality.

This account of what interpretation is, and of what makes one interpretation succeed and another fail, cannot hold only for legal reasoning, however. It must hold for interpretation in general, and so I was required to explore other domains of interpretation. In one important chapter of *Justice for Hedgehogs*, I concentrated on artistic and literary interpretation. I tried to show how the ‘value’ theory of interpretation illuminates the agreements and conflicts among critics in all these domains.

The interpretive theory of law raises deeper questions about moral philosophy. It supposes that one claim about the law – that capital punishment is unconstitutional, for instance – can be true and its opposite false, even though its truth depends on a moral theory about the best interpretation of the Constitution as a whole. But for many decades now most influential moral philosophers have denied this. They insist that claims about morality – that capital punishment is morally wrong, for example – are not really judgments and so cannot be either true or false. Since judgments about moral rights and duties cannot be empirically tested, these philosophers say, it makes no sense to think that they are either true or false. We must either concede that such judgments are, strictly speaking, nonsense, or we must suppose that they are not really judgments at all, but only expressions of emotion or recommendations for conduct.

Now this ‘anti-realist’ theory about morality, as it is called, would cause great trouble for the interpretive account of law I defend. We would have to say something that seems crazy, which is that nothing we say about the law is true – or false either. That may be an attractive conclusion to reach in a philosophy seminar room, but not in a court of law. A judge who sentenced a defendant to jail while admitting that the judge’s own view of the law is only an emotional expression would probably be sent to jail himself.

So I had to take a position on this deep issue of moral theory. In an article in 1991, and then in a fuller version of that article in the first part of *Justice for Hedgehogs*, I argued that the “anti-realist” view is in fact incoherent. Consider the proposition that rich people have no moral duty to help the poor of their own community. If that proposition is true, then it is not true that rich people have that duty, and that is itself a moral claim. If no moral claim can be true or false, then that one cannot be true either,

so anti-realism is self-defeating. Now that simple statement may seem too ready an argument and in actual fact it took me many pages to develop it. I had to consider a great variety of metaphysical arguments, proposed by a great many very distinguished philosophers, for the position I called incoherent. I cannot attempt to summarize those arguments now, but only to emphasize that this excursion into metaphysics was not for me optional. It was required by way of defence of a theory of law, which was in turn required by politically very important positions I wished to defend in constitutional law. We cannot pick apart these various philosophical issues and call some of practical and others of only theoretical importance. Politics and philosophy are much too closely integrated for that.

Anti-realism in moral theory is premised on a more general theory of truth we might call 'scientism'. This holds that the methods of the physical sciences provide the gold standard for any investigation, that only when these methods are available is it proper to speak of truth. According to scientism, once we see that moral argument is not amenable to scientific methods, we must abandon the idea that there is truth in morality. We must find some other account of moral discourse – that it is only nonsense or only emotional goading, for example. I rejected scientism, but I however needed another more general account of the idea of truth that showed scientific methods to be appropriate for the pursuit of truth in science but other methods to be appropriate to that pursuit in other intellectual departments. This required a very abstract theory of truth; I present one in *Justice for Hedgehogs*. Following a particular understanding of the philosophy of Peirce, I suggest defining truth, in the abstract, as success in inquiry, leaving further definition of truth as a substantive matter within different intellectual departments and so producing more distinct and tailored accounts of truth there. This merger of theories of truth with substantive theories that are different in different areas makes the world of truth safe for value.

However, even if I am right in all this, it establishes only that there is truth in morality and politics and therefore in law. It remains to ask what truth there is. What is a life well-lived? What duties do we owe as individuals to other individuals? What duties do we collectively owe to others in politics? What is Justice? Liberty? Equality? Democracy? Yes, it is crucial to establish that there are, in principle, better and worse answers to these questions, and therefore a best answer and therefore a true answer. But only if we go further and try to identify, so far as we can, what these right, true answers really are. I suggested that this could not be done piecemeal, taking one duty or one political virtue at a time. We had to try to answer the great moral and political questions all together, the way we solve a complex series of simultaneous equations in mathematics.

I therefore proposed two fundamental principles that I believe can provide the most coherent and attractive answers to all these questions. First, that it is objectively important – important from everyone’s point of view – that each human life succeeds rather than fails: that people live well. Second, that each person has a fundamental, inalienable responsibility to take charge of his or her own life: that it is finally up to that person to decide what living well would mean and to pursue that life.

These may strike you as elitist and in any case, for most people, unrealizable demands. But in *Justice for Hedgehogs* I argued, to the contrary, that people in radically different economic and cultural situations can recognize that their lives are important and can recognize what their own responsibility to live well, in their own circumstances, means. I argued, relying on Immanuel Kant’s thesis that no one respects his own humanity who does not respect humanity in other people, that we can define what we owe to other people as part of what we owe to ourselves. The key is the idea of dignity: it belongs to our own dignity to respect the dignity of other people.

I could not, however, defend this account of personal and moral responsibility without recognizing the persistent and deep challenge to any theory of responsibility: the argument that people cannot be responsible because, in a deterministic universe, people have no free will, cannot actually make choices, and so cannot be responsible for choice. The so-called ‘free will’ problem has been a threat to human responsibility for many centuries. I argued that it has been misunderstood: that the claim that we lack responsibility because we lack free will must be understood as an ethical and not a physical or metaphysical thesis, and that once the challenge is understood that way, the better answer is that people are morally responsible after all.

That brings us to politics, and to the great political virtues. The concepts of justice, liberty, equality and democracy are, like the concept of law, interpretive concepts. We argue about the right way to understand these concepts by arguing about how they should be understood given the crucial role they play in political discourse. I propose, again, that we should understand them as reflecting the two principles of dignity that I have argued are fundamental in private morality: these two principles form the spine of public political morality as well. And again we need to define them together so that they offer mutual support, not conflict. We achieve true economic equality, for example, not when everyone has the same wealth, no matter what decisions he has made in the course of his life, but when what one has, depends only on those decisions, and not on good or bad luck in health, accident, or inheritance.

That idea of equality ties together the moral ideal of personal responsibility and the political ideals of distributive justice. But how can equality so understood be achieved in a real political economy when good and bad luck are facts of life? I proposed what

I believe to be an economically sophisticated theory of taxation by way of answer: a redistributive tax system should be modeled on a hypothetical insurance scheme. The fortunate should pay, by way of taxes, what that model suggests they would have paid, by way of premiums, in an actual insurance market; the unfortunate should receive, by way of social benefits, what they would have been entitled to receive in that insurance market.

I recognize that this account of the philosophical basis of economic equality is much too condensed. I have explained it at much greater length elsewhere, particularly in my book *Sovereign Virtue*. My point, yet again, is only to suggest the interconnectedness among concrete legal issues, questions of personal ethics and morality, broad political issues of social policy, and the most abstract, rarefied philosophical and metaphysical puzzles. They cannot be separated, and my own career has been driven by their deep integration.

Comments and Questions

Karlheinz Stierle

Thank you, Ronald Dworkin. You can hear from the sustained applause that we were fascinated by your way of demonstrating your progression from law to philosophy, but also what it means to come back from philosophy to very elementary practical and reasonable every day questions of justice. This also raises the eternal question: what does 'justice' mean?

It is my privilege to put another question to you. In spite of what you said, I somehow feel, not being a lawyer, a little bit silly in doing that. Even with an interdisciplinary approach, are there not two different ways, one from law to philosophy and one from philosophy to law? Is there not always a disciplinary background that decides also the style, the particular way of thinking of a philosopher in regard to legal matters and how a lawyer conceives of philosophy?

My second question would be: when it comes to the crucial question of free will, is your idea of different intellectual departments not a kind of reaffirmation of C.P. Snow's *The Two Cultures*, and is it perhaps necessary to maintain and defend that difference that has been much debated and very often frowned upon? I think that your argumentation shows that it still has a value of its own when it comes to decisive questions of law and philosophy.

Ronald Dworkin

Thank you very much. I very much agree that it is equally important to go back from philosophy to law. I found out the other day rather frighteningly that I have writ-

ten well over a hundred articles for the *New York Review of Books*, trying to do exactly that – over the course of many years, I am afraid. In the course of those articles, I have endeavoured to bring all the philosophical assumptions, not simplifying them, but just collecting them, so as to bear on a range of problems of American Constitutional Law. I have written about free speech, about affirmative action, about sexual discrimination. In each case attempting to approach these not from a political, but a more abstract point of view, so I completely agree with you. Now, on the question of C.P. Snow, I think he was, as a professor at Cambridge, irritated by the independence of these two cultures, the fact that they operated as rival parties, indeed as rival ethnic groups within the academy, they did not talk to one another. He bemoaned that, and I actually think that once we confront scientism, we remove one of the prejudices that nourishes that kind of segregation. It is a prejudice on both sides. Scientists think, to use William James words, that people in the humanities are ‘soft headed’, and I think people in the humanities correspondingly think that people in science are insensitive; they just care about data and nothing else. The two earlier talks we had today seem to me very much to show the value in each of them in rejecting that kind of approach. I hope C.P. Snow would approve of what I have said.

Karlheinz Stierle

Thank you very much, Ronald Dworkin. It was a real privilege to listen to you and a great honour for us all.

It is a pleasure for me to now present Professor Gottfried Scholz, Chair of the Prize for Musicology Balzan special committee. Gottfried Scholz is Professor Emeritus of Music Analysis at the University of Music and Performing Arts, Vienna; Fellow of the Sudetendeutsche Akademie der Wissenschaften und Künste, Munich. He will now present our Prizewinner in Musicology.

Presentation of Reinhard Strohm, 2012 Balzan Prize for Musicology

Gottfried Scholz

Thank you, Chairman. In the long history of the Balzan Prize, it is the second time that Musicology has been chosen as a subject area. It is both a privilege and an honour for me to say a few words about our Prizewinner Reinhard Strohm.

The important musicological work of Reinhard Strohm covers over half a millennium of the history of European music. His research focuses on the Franco-Flemish region in the late Middle Ages and the tradition of Italian *opera seria*, in particular the works of Antonio Vivaldi and George Frideric Handel.

As in the field of his research as a whole, Reinhard Strohm's musicological presentations are set in a context of general historic-cultural and historic-social considerations concerning the respective periods in Europe. In this way, he has contributed to a new understanding of what musicology means. Not only by offering biographies of composers and analyzing particular musical works, but also in seeing music as an expression of human ideas, spirit and social behaviour under certain conditions, including diverse political and economic situations.

I would also like to point out the three cities he has dealt with in particular, delving deep into primary sources to bring us some outstanding publications, namely Bruges, London in regard to Handel, and Rome, of course, in the context of the Italian *opera seria*, especially in the eighteenth century. Since Reinhard Strohm's interests centre on vocal music, he has also included in his analysis poetic models as well as historic-literary references.

As an academic at leading universities particularly in England, at Oxford University, and in America, he has inspired generations of music scholars. We are also very proud that he had the time to come recently to Vienna to impart some of his wisdom. It gives me great pleasure to ask Professor Strohm now to take the floor.

Reinhard Strohm

My Work and Worries in Music History

Thank you very much, Gottfried Scholz. Chairman, ladies and gentlemen: my profession is that of a music historian, and it is in this capacity that the Balzan Foundation has honoured me with this prestigious prize. The least I can do to express my gratitude, is to demonstrate here why the history of music seems a worthwhile pursuit to me, and what I have tried to achieve in it. But there are some massive doubts in my mind. Is it actually the case that music can have a history? What have I done to prove its validity?

Audiences today experience music from the past in classical concerts, for example. These are strange events. Imagine that a visitor from a remote culture, like the characters of Montesquieu's *Lettres persanes*, attends such a concert and writes home about it. The fact alone that there are performances of music composed centuries ago surprises our visitor. He wonders why many people in the audience accept the music as something coming from the past, although it is actually 'made' in the present. They even use programme notes which comment on the historical composers. Admittedly, a few listeners seem unconcerned about the provenance of the music, but simply enjoy

it as a present. Even they, however, have heard it before. The visitor can empathise with the latter attitude, which accepts the musical experience as provided only by tradition or convention, not by history. The other attitude remains strange to him.

To accept music as provided by history is a peculiar practice not only when seen from outside our culture. In our own industrialised environment of today, the non-historical attitude is far more common. It concerns many types of music, performed on various transmitters such as CDs, television, radio, computers and film. Despite the time-lag between recording and listening in electronic media, music lives in the present, as performance and as aural experience. When we ask how it comes to us here and now, a logical answer is that music, like most other cultural goods, is provided by our own technology and markets. All cultural products seem equally available in today's world, while the sources from which each of them comes, appear secondary: they can be made up. The dividing line between the mechanical reproduction of the art-work, assessed by Walter Benjamin in 1936,⁶ and a mechanical *production* of it, is disappearing. Even 'medieval music' is being composed today, in order to be sold in digitised form. In a reconstitution of the cultural hierarchies, the aura and the authority of the past in music – Benjamin also used the term 'authenticity' for it – are being replaced by the aura and authority of the label, the service industry. Listener's attitudes to the 'historicity' of music, if I may use the term, have changed within our lifetimes. I remember concerts and radio broadcasts of the 1960s when the upsetting amount of dissonance in a new work by Stockhausen or Nono was felt to be a function of its novelty. 'Modern' was an evaluative term. Aesthetic appreciation was associated with historical depth, for some people in inverse relation. But post-modern audiences no longer seem to make such connections.

Other arts are similarly being stripped of their historical depth today, or as some may put it, they are freed from their eurocentric shackles. The two processes are connected insofar as the historicity of art is a typically European discourse, which has itself created most of the art in question. But the grand narrative of art as a historical phenomenon, aesthetically determined by ancestry, aura, imitation and emulation of the past, has come or is coming to an end in our lifetimes. The title of Hans Belting's monograph *Das Ende der Kunstgeschichte* (1983) refers in the first instance to the crisis of an academic discipline only, but its main thesis is also about the cultural significance of art in everyday life and thus concerns the situation of the performing arts,

⁶ Walter Benjamin, *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* (1935), French first edition 1936, German edition Frankfurt: Suhrkamp, 1963.

too. Instead of the question of where a work of art comes from, and who originated it, scholars ask with what sort of images, what sort of sounds we are surrounding ourselves. The conceptual transformation of Western 'art' into a segment of universal affordances in the global industrialised civilisation started around 1950, when André Malraux first brought together his appreciation of non-Western art and his idea of a 'museum without walls'.⁷ The eurocentric bit in Malraux's conception was that a museum, not a historical narrative, was required to incorporate non-Western art into our consciousness.

* * *

Half a millennium before, Renaissance humanists had recognised that the Roman temples and palaces were not just a museum without walls, but an ancient form of tradition, a benchmark for imitation and emulation: they harboured a grand narrative. This idea could not have arisen without the paradigmatic status of literature. Greek and Roman literary works, transmitted in written codices, already formed a canon that challenged contemporaries. Petrarch's recognition of this trans-epochal relationship soon inspired the visual arts, for example of Leon Battista Alberti. Humanist authors wrote about the lives of artists (as did Giorgio Vasari in 1550), or about the invention and reception of music (as did Johannes Tinctoris ca. 1480); artists began to emulate the ancients and each other – in the latter case including composers of music – and they all believed they had to achieve progress. The benchmark character of art enabled its historicity; the stepping-stones between earlier and later art were competing masterworks. The concept of the masterwork in music, as I concluded after having published my book on fifteenth-century music, was triggered by the revival of antiquity, the *rinascita*: in fact, the works of a Dunstaple, Du Fay, Ockeghem or Josquin were then measured against the yardstick of Cicero, Horace and Virgil. That a 'modern system of the arts'⁸ could finally arise out of a blending of the *quadrivium* with the *artes mechanicae* of the Middle Ages, implied the discourse of art as a series of historical artefacts. The quadrivial arts had been sciences, whose lasting validity rested on the standards of scientific truth; the *artes mechanicae* created artefacts but without theory and thus without history. Renaissance authors – and musicians – introduced the con-

⁷ André Malraux, *Les voix du silence*, Paris, 1951, with the essay 'Le musée imaginaire' of 1947 as its first part.

⁸ Paul O. Kristeller, 'The modern system of the arts', in *Renaissance Thought: Papers on Humanism and the Arts, I-II*, New York: Harper, 1965, 163-227.

cept of the *artes poeticae*. These ‘work-creating’ disciplines had a history *because* the objectivation of creative activity in ‘works’ made historical hindsight possible.

The habit of early modern composers to use old melodies, so-called *cantus firmi*, over and over, to build their ever more advanced musical structures around them, was not just traditionality. The procedure created a yardstick, against which progress of the art could be measured. It enabled innovation, precisely as each work, following the procedure, demonstrated the one solution that could not be tried again. The normative function of past artefacts – which is common to all cultures – becomes a historical narrative at the point where there is a deliberate deviation from the model. Mozart wrote in a letter to his father that he was excited to find out whether he could set the words of the aria “Ah, non lasciarmi, no” in a very different way to Baldassare Galuppi.⁹ Once Mozart’s aria was composed, the two settings were not equivalent affordances of a culture, but distinct steps on a ladder, the second presupposing the first. In the twentieth century, Arnold Schoenberg justified the dodecaphonic method out of the logic of musical history itself. He thought of new music teleologically as a conclusion of the classics, a synthesis of the dialectic premisses of history. When supporters of the de-historicisation of music today tell us that it is absurd to ‘listen to music more than 90 years old’, they are falling prey to exactly that teleology of musical progress which they claim to despise.

Historicism is the active recognition of the modifying nature of history upon the objects of our life-world. And, according to Reinhart Koselleck and the ‘Constance School’ of literary theory, history is a function of the present and the histories of literature and art serve to modulate the artefacts of the past to today’s expectations. I suggest that in music, too, the possibility of separating out transmittable works of the past from the general aural resource not only produced the idea of a classical, mainstream Western musical tradition: it has produced or at least legitimised the respective music itself.¹⁰ Composers operate with history in mind. Schoenberg, Wagner, Verdi, Mozart and already Handel and Bach consciously composed for posterity; about Jean Ockeghem it was said in his own time that he left written works which posterity still

⁹ Wolfgang Plath, *Mozart und Galuppi. Bemerkungen zur Szene „Ah, non lasciarmi, no“ KV 295a*, in: *Festschrift Walter Senn zum 70. Geburtstag*, ed. by Tiroler Landesmuseum, Erich Egg and Ewald Fässler, München-Salzburg: Katzbichler, 1975, 174–178.

¹⁰ „Werk – Performanz – Konsum: Der musikalische Werk-Diskurs“, public lecture held at Vienna University on 28 March 2012, in: *Historische Musikwissenschaft: Grundlagen und Perspektiven*, Michele Calella und Nikolaus Urbanek (Hrsg.), Metzler Verlag, 2013.

admired.¹¹ In my studies of the musical work-concept, I found that the grand narrative of the historical development of the arts is a product of Renaissance humanism – and it is coming to an end in our days. The end of the Middle Ages, a construct of Renaissance humanist thought, is now paralleled by the end of Modernity, like the opening and closing of a loop in cultural history.¹² In the same way as humanists rejected the culture of the preceding centuries as a ‘dark age’,¹³ being more attracted by the remote culture of antiquity, the post-modern ideology rejects modernity and the humanist-inspired Western culture. This ‘divided retrospection’, as I call it, has anthropological implications which we should learn about.¹⁴ But if we have rejected modernity and the centuries of Western culture that led up to it, where is the *rinascita* of our time?

* * *

Thus my first doubt about music history concerned its contingency, its anomalousness from a wider historical perspective. While music has this in common with other branches of Western art and history, it may also be argued that music is *by its own nature* incapable of being historicised. It is an art that vanishes as it is produced; since it cannot be written down, it will not last, as Isidore of Seville believed. Where music writing exists (not only in Western cultures), the written sign in music seems much farther away from the performance than it does in language, for example. Memory plays a larger role in producing and receiving music than in the practices of literature or painting. A word by itself is meaningful, a musical note is not; any significance of musical expression is achieved through relationships, not self-contained symbols. Historians of music always endeavour to establish musical hermeneutics, and to read compositions as metaphors of their times or social groups: perhaps these are misguided imitations of what the historians of literature legitimately do.¹⁵ On the other hand, memory is important in many arts, not only the

¹¹ “‘Opus’: an aspect of the early history of the musical work-concept”, in *Complexus effectuum musicologiae. Studia Mirosłavo Perz septuagenario dedicata*, ed. Tomasz Jeż, Kraków: Rabid, 2003, 309-19; revised repr. in: *Musik des Mittelalters und der Renaissance: Festschrift für Klaus-Jürgen Sachs zum 80. Geburtstag*, ed. Raner Kleinertz, Christoph Flamm and Wolf Frobenius, Hildesheim: Olms, 2010, 205-17.

¹² ‘Zmierzch średnowiecza a zmierzch nowożytności’ (The End of the Middle Ages and the End of Modernity), *Przegląd Muzykologiczny* 2, no. 2 (2002), 153-172.

¹³ Theodore Mommsen, “Petrarch’s conception of the ‘Dark Ages’”, *“Speculum”* 17/2 (1942), 226-42.

¹⁴ ‘The Legitimacy of “Early European Music”’, in *Cambridge Handbook of Medieval Music*, ed. Marc Everist, Cambridge: Cambridge University Press, forthcoming.

¹⁵ ‘Eighteenth-Century Music as a Socio-Political Metaphor?’, *The Century of Bach and Mozart: Perspectives on Historiography, Composition, Theory and Performance in Honor of Christoph Wolff*, ed. Sean Gal-

performing ones: there is a fascinating stability of oral transmission within many types of communities, and music seems essential to the most widespread and important social actions. Sacred song and ritual music have interested me since my childhood, although I have only very recently dared to write about them.¹⁶ When such practices remain stable over centuries, it may be not because oral memory is more reliable than written transmission here, but because remembered music seems so powerful in the minds of individuals and collectives. Perhaps the reason is exactly that music does not carry the burden of a specific meaning as an *a priori* intention, but only of that meaning that is given to it by the receiving ear and soul. However, from memory alone, even from trans-generational collective memory alone, no history may be constructed, as I learnt from Paul Ricœur.¹⁷ Thucydides and Polybius should have acknowledged this, although the highlights of their narratives concern events they have personally witnessed. The incessant border-skirmishes about the respective importance of oral and written traditions, in which as a musical medievalist I participated, seem to be missing the point. The two practices encapsulate each other: in the Middle Ages, writing did not take anything away from memory and orality. Orality was the ocean; writing was a ship. Generally speaking, the medium is not the message (unless you wish to sell it). From all these points of view, the writing of Western music history is not fundamentally different from the writing of any other history; it can be tolerated. History is a young child walking at the hand of big sister Memory, whose liaison with the highest god has given us the arts and sciences.

In my student years, I was intrigued by music writing, symbols, cryptic codes, palaeography, number games and figures. I loved music transcribing and editing, which seemed to me the next best thing to singing and playing. The *homo ludens* was alive around music. In my first semester I dabbled with medieval music fragments in the Munich library; in my dissertation I devoted an entire chapter to a structuralist presentation of all the possible rhythmic relations between words and notes in Italian opera arias.¹⁸ Only by chance did I avoid the error of believing that historical music varies according to functional criteria reconstructible from the respective cultural context. But this has remained a

lagher and Thomas Forrest Kelly, Cambridge, MA: Harvard University Press, 2008 (Harvard Publications in Music, 22), 279-296.

¹⁶ 'Late-medieval sacred songs: tradition, memory and history' (2006 Gordon Athol Anderson Memorial Lecture), in *Identity and Locality in Early European Music, 1028-1740*, ed. Jason Stoessel, Farnham: Ashgate, 2009, 129-48; some of this was influenced by Jan Assmann.

¹⁷ Paul Ricœur, *La mémoire, l'histoire, l'oubli*, Paris: Seuil, c. 2000.

¹⁸ *Italienische Opernarien des frühen Settecento (1720-1730)*, 2 vols., Cologne: Gerig, 1976 (Analecta musicologica 13).

widespread fallacy, especially where the underlying Hegelian assumption of the *Zeitgeist* as the largest common denominator of cultural products is not checked. In the 1980s I read in a New England concert announcement: ‘Bach’s music is written in the Baroque style, a very expressive and dramatic idiom.’ So, Bach had that one on his shelf, too! The style of his four-part chorales, for that matter, has been reproduced, badly enough, with computer programs. Notwithstanding this naïve underbelly of the great structuralist narrative, I do confess my ongoing admiration for musical analysis, even in its strictest a-historical forms, as long as their practitioners do not tyrannise us music historians, which we had reason to fear in the 1970s. In 1990 – when the analytical wave was already declining – I advocated the compromise of *historical analysis*: this approach did not set out to prove how music works (as the radical analysts do); it did not even prove how a particular piece of music works (as the moderate analysts do); it only showed how a piece of music *did* work at the time it was made.¹⁹ The eminent Leo Treitler created a much more elegant formula for the synthesis of musical analysis and history, which would occupy me for years: ‘that the history of music can only be written by showing the history within the musical works themselves’.²⁰ The idea, also adumbrated by Peter Bürger for art in general, comes from the Frankfurt School and is ultimately, I believe, Hegelian in its clever direction to turn the enquiring eye inward rather than outward. Above all, Treitler’s formula allowed me as a musician to cling to the music while being a historian – for a while.

The wave of the cultural turns had just about reached musicology by the 1990s. With the help of well-informed friends such as Michael Fend and Laurence Dreyfus I discovered post-modern historiography, interlaced with bits of hermeneutics, action theory and phenomenology. Nevertheless, it was difficult to hold on to that powerful wheel of scholarly fortunes that the cultural turns had set in motion, and sometimes historians like myself did not really know where they stood or were hanging. The moment of truth came for me through the *Festschrift* given me at age 65: the editors, Melania Bucciarelli and Berta Joncus, had entitled it *Music as Social and Cultural Practice*. Although the phrase was rather similar to the title of someone else’s book, it had at least the redeeming qualities of lacking a present participle and of not using the word ‘context’. The question it raised was whether I could recognise myself in it, whether my work so far had emphasised social practice and human actions rather than music itself. The editors were probably right: I had

¹⁹ ‘Musical analysis as part of musical history’, *Tendenze e metodi nella ricerca musicologica. Atti del convegno internazionale (Latina 27-29 settembre 1990)*, ed. Raffaele Pozzi, Florence: Olschki, 1995, 61-81.

²⁰ Leo Treitler, *What Kind of Story is History?*, in: Leo Treitler, *Music and the Historical Imagination*, Cambridge, MA: Harvard University Press, 1989, 157-175 at 173.

in fact published essays advocating the concept of music as action, to which the categories of creation, reception and interpretation should be subordinated.²¹ Adopting action theory and phenomenology for music still seems a viable path to me. But there are still the old questions and doubts about the relationship between people, who make history, and music, who makes the present. Are we actually writing music history when describing the musical practices of a medieval city, or the opera productions of Vivaldi? Or are we just amateur general historians? Are we writing music history when working out the numerical structures of a motet by Du Fay? Or are we less-than-amateur mathematicians? These doubts seem far more momentous than the two previous ones, i.e., the one about the historical contingency of music history-writing, and the one about the ontological nature of music as a mnemonic sign-system.

My feeling is that we should *not* reduce music to a social and cultural practice, at least as long as we feel ourselves that this would be a reduction. I was fortunate enough to find words for this feeling at another conference, in 1999. In a slightly tense atmosphere, ethnomusicologists started moaning about my paper on post-modern challenges of music historiography.²² I heard the spontaneous objection: “How can you say that about history? You weren’t there!” I explained that, as a historian, I was bound to talk occasionally of things outside my first-hand experience. No matter, near the end of the discussion a friendlier member of the audience thought she had to give me another chance to please them, and asked: “Mr Strohm, what do you think music *is*?” (Gretchenfrage). I replied: “Music is social and cultural practice.” Loud, demonstrative applause; peace was re-established. Then I said: “And, one can also say that music is in the mind.” A few hesitant claps. Then I said: “And, some people have also thought that music is in the stars.” You cannot imagine that silence; it was as if the harmony of the spheres would next be heard. Of course, this was not the silence of peace.

* * *

It is very strange that my example of the harmony of the spheres left ethnomusicologists speechless, because this musical imagination was shared by the ancient Greeks and the ancient Chinese. Thus, while I asserted that there is more to music

²¹ ‘Darstellung, Aktion und Interesse in der höfischen Opernkunst’, in *Musik und Theater als Medien höfischer Repräsentation* (Conference report), *Händel-Jahrbuch* 49 (2003), 13-26.

²² ‘Postmodern Thought and the History of Music: Some Intersections’, *Revista Portuguesa de Musicologia* 9 (1999), 7-24.

than social cultural practice, more indeed than an 'ethnographic present', which can only be researched 'being there', my example also appealed to the testimony of a remote culture. A view from outside onto the Western cultural paradigm has proven beneficial to my argument. My attitude towards this outside has always been egotistic, exploitative, as you may say. It was so easy to learn more about our own culture by considering the alternatives. In the early 1990s, my students and I had immense fun in a semester when we transcribed gamelan music by ear into Western notation; of course we learned much more about the latter than about the former. At the Faculty of Music in Oxford, I campaigned for years for the establishment of an ethnomusicological lectureship – which we finally got; my simple motivation was that we needed that heterocentric viewpoint. In the course of those years, I also came to believe that alterity values reside both without and within our own traditions and practices. The Romantic medievalism which had attracted me to the civilisation of late-medieval Bruges, the interest in number games and sign-systems, the fascination with structural analysis, were the longings of a European student who could not accept that everything in art was supposed to be intention, meaning, social action, authority and history. In my book of 1993, I described the process of the coming together of different intra-European musical traditions under the title 'Diversity and participation'.²³ Later, besides being on the lookout for the special historicity of medieval hymns such as *In dulci jubilo* – an alterity at home – I discovered utopia and read dozens of utopian novels that mention music. The idea was that the European geographic utopia of the early modern era, which had been triggered by the discoveries of other world regions, rivalled with the pastoral in representing an alternative way of making music in society.²⁴ Ultimately, of course, the pastoral and the utopia have similar goals, although the former appeals to aristocratic hedonism, whereas the latter often adopts a protestant rigour. Both depict socio-cultural practices of music that are far from us – far in the past or far across the oceans. More recent utopias look far into the future. All of these narratives shed some light back on us. Of course, modern Western musicians cannot accept their paradigms: pastoral and utopian societies have in common, for example, that usually nobody is paid for music-making. But it is the mental motion of these stories that deserves our attention. The continuous attempts of European authors to map self-critical imagination onto information from real non-European societies may

²³ *The Rise of European Music (1380-1500)*, Cambridge: Cambridge University Press, 1993 (xv, 720 pp.).

²⁴ 'Les Sauvages, music in utopia, and the decline of the courtly pastoral', *Il Saggiatore musicale* 11 (2004), n. 1, 21-49.

seem redundant, a fairy-tale – but they demonstrate an engagement with difference. And, whatever is being imagined about the social structures and practices, the music is always different from ours.

I do not know how many writers on Renaissance humanism have observed that the revival of antiquity was actually a longing for difference. Europeans like to count classical antiquity as their own culture, but the differences remain enormous. In music, the distance is so considerable that only a handful of ancient Greek tunes has been recovered today. In 1724, the Jesuit Father Lafitau published a four-volume work about the rituals and music of the North American Indians, which he compared to those of classical Greece.²⁵ This was not an example of the colonialist lie that all savages are the same, but an effort to historicise difference, in the wake of many debates, especially in France and England, about the respective legitimacy of ancient and modern or diverse national cultures. I have been inspired by Lafitau and similar writers, as well as by medievalists and the French Annales School, to explore diverse kinds of historicity in music. My Balzan research project “Towards a Global History of Music” is intended to explore musical interactions between Western civilisations and those of other world regions in history. It occurs to me that the validity of our traditional music historiography might be tested on the wider level of a global music history. If we investigate the cultures of other world regions or indeed our own oral and non-learned traditions, we also wish to know what musicians from those traditions, when they visit, write home about us. Can we ever put all the “Persian” letters together to make a history? The outreach of music history towards a global discourse would be comparable in scope to what Renaissance humanists were attempting with classical antiquity; so this could be a *rinascita* of music.

Comments and Questions

Karlheinz Stierle

Thank you very much, Reinhard Strohm, for your reflections, those of someone who has had a magnificent career as a historian of music, who all of a sudden has doubts about what he has done in the context of where history becomes problematic in the sense that the concept of the ‘end of history’ rears its head.

²⁵ Joseph-François Lafitau, S.J., *Moeurs des sauvages américains comparées aux mœurs des premiers temps*, 4 vols., Paris, 1724.

The 'end of history' is a concept that is not entirely new. We know that Nietzsche dreamed of the end of God; Hegel dreamed of the end of Art. There are quite a lot of terms. The field is complicated and I will try and navigate it as I use my privilege of asking a question. I will initially pose a simple query in relation to the theme of interdisciplinary research.

One of your special fields is eighteenth-century Italian opera. What is the relationship between text and music? Does the text of the opera, the libretto, belong to the history of literature and the music to the history of music, or are they both considered interdisciplinary? Is the interdisciplinary dialogue different in the different separate contexts of literary history and musical history? Finally, is historicity not a trans-historical aesthetic experience? As a literary historian with no regrets at having chosen this path, my sense is that it is absolutely necessary to have a historical background where we can arrive at an aesthetic experience which transcends the historical moment of the creation of the work.

Reinhard Strohm

Thank you very much. This is an exciting and complex set of questions. The very first point that comes to my mind is that the 'end of history', the end of this and the end of that, are simply hypotheses. I remember vividly the book by Hans Belting, *Das Ende der Kunstgeschichte*, and so on. I think these questions were all raised by people who believed in history. They were in a sense apocalyptic writings created by individuals wedded to a Western idea of historicization and historiography. What I was trying to characterize here is that the next stage is when people no longer care. History would be flattened out into a universal present of affordances, and that the idea that history has not actually ended but rather it never existed, an idea adhered to by quite a few people today, frightens me.

What I advocate is viewing history as the basis to understand change, to put it on a different level, a different framework. Renaissance humanists to some extent have been able to see that. They had great influence on Western historiography, contributing the conceptualization of the Middle Ages and antiquity as different phases of history where very strong aesthetic moral and social positions were taken. In condemning the 'father' culture and loving the 'grandfather' culture, an historical point was made that history has a meaning and that historical meaning has to some extent disappeared now.

As regards Italian opera, the interdisciplinarity we are talking about, I take it in a limited sense which is perhaps more valuable than a generalized one and the related

research. The academic disciplines must cooperate to understand creations such as opera and other works. The creators of these works themselves do not work in an interdisciplinary plane. That is not really an issue for them. They do, however, of course cooperate. Opera is a typical example of this kind of cooperation. I think in artistic creation the idea of interdisciplinarity applies in a different way.

We have a nineteenth-century derived division of specializations between the sciences and the arts. I think it is a good thing that we have this, or otherwise many things would not have been discovered. We have needed to diversify in order to capture the enormity of the world better, and interdisciplinarity should not undermine this or undo this split between the main disciplines. The obvious implication is that when we have a division of labour we have a common goal. However, the way in which the artistic elements work together in opera is altogether a different matter. I think it has to do with trying to capture human perception. Human perception requires a deeper understanding. What do we perceive when we listen to vocal music? One possible response to these wide-ranging questions is that when you go to a classical opera performance today, it will be sung in a language that you do not understand. It will be sung in an acoustic environment, for example, with an orchestra where you cannot make out the words. You have subtitles provided. A false interdisciplinarity is forced upon us by this system, where unity of perception would have been required: when reading the words and at the same time listening to the music, I think there is a danger that you read the words like a commentary on what is allegedly happening on stage; the music becomes a background to that. You do not hear the actual people singing to you, using words as their individual expression. That is because we have the wrong opera houses, the wrong kind of relationship between the audience and those on stage. We need to re-establish people-to-people performances. The unity of communication in opera could thus be rescued.

Karlheinz Stierle

Thank you very much, Reinhard Strohm, for a most illuminating and original presentation. At this stage, I would like to thank everyone for their participation in this year's Prizewinners' Interdisciplinary Forum. It remains only for me to hand over to Ambassador Bottai and to Professor Quadrio Curzio for their closing remarks.

Closing Remarks

Alberto Quadrio Curzio

We have reached the end of this splendid forum. I wish to convey on behalf of the Accademia Nazionale dei Lincei my appreciation and thanks in relation to these successful series of events in Rome, recognizing the substantial contributions of the various Prizewinners and speakers in the context of the traditions of the Balzan Foundation.

Bruno Bottai, President of the International Balzan Foundation “Prize”

As President of the International Balzan Foundation “Prize”, I congratulate the 2012 Prizewinners and thank them for their contributions. I wish to congratulate the General Prize Committee and its Chairman Salvatore Veca for the excellent choices again made this year, after much intensive deliberations.

The prestige of the Foundation is entirely due to the calibre of the Balzan Prizewinners. This Forum represents a unique opportunity to have our Prizewinners interact and discuss issues of a relevant interdisciplinary nature. Indeed, this year has again provided a most useful and lively exchange. The increasing interdisciplinary focus of the Balzan Foundation is also the result of the efforts of Alberto Quadrio Curzio, through the establishment of ties with both the Accademia Nazionale dei Lincei and the Swiss Academies of Arts and Sciences. This year, we have had an extremely successful interdisciplinary laboratory, which has very effectively showcased another essential element of the Prize, the participation of young researchers. This laboratory involved previous Balzan Prizewinners, and academics from the Balzan General Prize Committee, the Lincei and the Swiss Academies, engaging in a round table discussion with a select group of young researchers, some of whom are involved in Balzan research projects.

The organization of the laboratory also echoed the Balzan Foundation’s essential Italian Swiss nexus. The Balzan Foundation acts jointly through two Foundations: one with headquarters in Milan, the “Prize” Foundation – chaired by myself – which through its General Prize Committee chooses the Balzan Prizewinners, and the second, the “Fund” Foundation, with headquarters in Zurich – chaired by Achille Casanova – which administers Eugenio Balzan’s estate. When, 50 years ago, Lina Balzan decided to honour the memory of her father Eugenio and to continue his charitable activities by devoting the patrimony he had left her, she ushered in a new model

of cultural and academic patronage. Since the establishment of the Balzan Foundation, we have awarded Prizes to 130 luminaries and 4 institutions throughout the world. Over the last 10 years, our Prizewinners have involved over 450 researchers in research projects financed by the second half of their Prizes, many of which have produced ground-breaking results.

Thank you to all those who have attended the 2012 Balzan Prizewinners' Interdisciplinary Forum. I look forward to seeing all of you in Berne next year.

Alberto Quadrio Curzio

I would like to compliment to Ambassador Bottai for such a warmly conveyed address. In my role as a representative of the Accademia Nazionale dei Lincei I will add my own thanks in particular to the two Balzan Foundations and the faith expressed by them in the Accademia Nazionale dei Lincei and the Swiss Academies of Arts and Sciences. Indeed, this forum has been jointly organized by the Balzan Foundation "Prize", the Accademia Nazionale dei Lincei and the Swiss Academies of Arts and Sciences. I wish to particularly express my thanks to Bruno Bottai, Chairman of the Balzan Foundation "Prize" and Achille Casanova, Chairman of the Balzan Foundation "Fund".

We have listened to some remarkable discourses today given by the Prizewinners and by those academics who presented the Prizewinners including the pertinent questions also posed. It would undoubtedly be very interesting to continue these discussions. To carry on a noble tradition of the Lincei, which is tied only to the most significant ceremonies, I have the pleasure to present a gift to the Prizewinners the *Lynceographum*, subtitled *Quo norma studiosae vitae Lynceorum philosophorum exponitur*. These are effectively the articles of constitution of the Accademia, drawn up by Federico Cesi, which he further elaborated through a dialogue with Galileo Galilei, where he explained how knowledge must be unitary, though at the same time recognizing everyone's specific competences.

A final aside, the Accademia Nazionale dei Lincei is celebrated for many concrete reasons. Some of Galileo's early discoveries were published under the auspices of the Accademia dei Lincei. Perhaps less known, but ascertained to by esteemed scholars, is the fact that the subject of modern natural history was initiated by the Lincei. The book I have in my hands is David Freedberg's *The Eye of the Lynx: Galileo, His Friends, and the Beginnings of Modern Natural History*, in which he not so much illustrates Galileo's discoveries, but rather deals with studies concentrating on the volume *Mexican Treasure - Rerum Medicarum Novae Hispaniae Thesaurus*,

above all in relation to the flora of Mexico. According to Freedberg, the collection of illustrations of Mexican flora and the investigations of the same represented in *Mexican Treasure* is a remarkable scientific innovation in terms of visual realization in the field of natural history. The original publication and later copies are held here in the Lincei. I have stressed this important aspect of the history of the Accademia Nazionale dei Lincei as it is one of the many examples of “curiosity” which is the engine of any discovery – in the past, in the present and in the future.

The 2012 Prizewinners' Research Projects

David Baulcombe, Regius Professor of Botany, Royal Society Research Professor and Head of the Department of Plant Sciences at the University of Cambridge, was awarded the 2012 Balzan Prize for Epigenetics *for his fundamental contribution to the understanding of epigenetics and its role in cell and tissue development under normal and stressful conditions.*

Further Investigation of Epigenetics in Hybrids and Evolution

The project is designed to address fundamental questions in biology using a genetic and molecular approach. The link with biology – in this instance evolutionary biology – is an essential component of this project. Molecular biologists are sometimes overly preoccupied with the naming of parts – scientific stamp collecting – rather than the biology of the systems. The project is also intended to introduce young scientists to the statistics and computational aspects of handling large datasets related to genome-wide profiling of epigenetic modification, gene expression and genome sequence. The advent of high throughput sequencing technology has been transformational in biology and their ability to use the resulting datasets is essential for their career progression as research scientists.

Part I is based on recent discoveries from Professor Baulcombe's laboratory determining that epigenetic marks affecting gene expression are initiated in the genomes of hybrid organisms.

It will have two stages. The first stage will involve dissection of an epigenetic change that we have observed already, to be initiated in hybrids between tomato – *Solanum lycopersicum* – and a wild relative – *S. pennellii*. When completed, the conclusions will give us a baseline for the analysis of other loci that will be identified in the second stage. This second stage will involve genome-wide characterisation of genetic and epigenetic changes in the *lycopersicum* x *pennellii* hybrids. This research will indicate the extent to which induced epigenetic changes might affect the phenotype of the hybrid plants.

Part II exploits the unicellular green alga – *Chlamydomonas reinhardtii* – to investigate the role of epigenetic mechanisms in adaptation.

The aim of the experiments is to test an hypothesis related to soft inheritance. It is to ask whether algae that are defective in soft inheritance are compromised in the ability to adapt to an altered environment.

The first stage will be to characterise mutant and knock down lines of *C. reinhardtii* for epigenetics and RNA silencing.

In parallel with this molecular biology preparation we will set up a series of long term culture experiments in which cultures are subject to mild stress herbicides and high CO₂. The detailed experimental regime will be designed in collaboration with Sinead Collins in the Edinburgh Institute of Evolutionary Biology with whom we are collaborating already and will take account of previous studies in which *C. reinhardtii* cultures were adapted to these stresses.

Part I will be carried out by a postdoctoral scientist and the Part II will be allocated to a four year PhD student.

Ronald Dworkin, Professor of Philosophy in the Philosophy Department and Frank Henry Sommer Professor of Law at the School of Law, New York University, and Emeritus Professor of Jurisprudence at Oxford University and University College London, was awarded the 2012 Balzan Prize for Jurisprudence *for his fundamental contributions to Jurisprudence, characterized by outstanding originality and clarity of thought in a continuing and fruitful interaction with ethical and political theories and with legal practices.*

Ronald Dworkin Balzan Prize Research Fellowships in Legal Philosophy

Due to the unfortunate and untimely death of Professor Dworkin, it was impossible to continue with his research project as originally envisaged since it was to be based on the elaboration of a body of work produced by Professor Dworkin himself. When it proved impossible for him to continue, he delegated responsibility for the project, and in conjunction with a colleague, Professor Liam Murphy of NYU, he elaborated another option to retain the essence of the project. Professor Murphy in respecting the wishes of Professor Dworkin has maintained the original themes but has shifted the emphasis of the project to include more young researchers and has instituted a fellowship programme over four years.

Kurt Lambeck, Emeritus Professor at the Australian National University since 2008 and President of the Federation of Asian Science Academies and Associations (since 2009), was awarded the 2012 Balzan Prize for Solid Earth Sciences, with emphasis on interdisciplinary research, *for his exceptional contribution to the understanding of the relationship between post-glacial rebound and sea level changes. His findings have radically modified climate science.*

Sea-Level Change during Glacial Cycles

Sea levels have changed throughout the Earth's history and have impacted on the movements of species between land masses, including human movements over the more recent period of the past 100,000 or so years. The causes include tectonic and climate processes and over the past million years it is the latter, with the cyclic growth and decay of the great ice sheets, that has been most important. Understanding how sea level has changed helps understand the fundamental processes that have shaped the earth through time. It is a truly interdisciplinary area of research involving the disciplines of solid-earth geophysics, geology and geochemistry, underpinned by physics and mathematics, with implications for past climates and human pre-history. The research component of the Balzan Prize will address some important elements of this broad subject.

Research Themes

1. *Geophysical modelling of interactions between ice sheets, the solid earth and sea level.* When ice sheets melt or grow they stress the earth and change the gravity field which together leads to a complex spatial pattern of sea level change. Modelling of these interactions rests on a number of hypotheses that need testing, something that is now possible because of both enhanced computational facilities and observational data. Numerical modelling developments will include refinement of our models through improved characterisation of the Earth's rheological parameters and improved inversions of field data for inferring the ice sheet history. One of the goals will be to develop a version of the numerical models suitable for use by 'non-experts' so as to make the methodology available to geologists and archaeologists. Another goal is to develop the next iteration of ice sheet models with a particular focus on the Antarctic ice sheet which up to now has played a rather passive role in the discussion of past sea levels, despite it being important in assessing the future of this ice sheet in a framework of a warming planet. Other

targets include an improved ice sheet model for southern Greenland and improvements in the North American ice sheet model. These models will provide improved reference points for testing climate models under conditions very different from today as well as the basis for palaeogeographic reconstructions during recent glacial cycles to explore possible constraints on human migrations.

2. *Past interglacials as analogs of the present interglacial.* The past interglacials that occur about every 110,000 years are periods when climate was similar to today and sea levels were close to present-day values. The last interglacial is particularly important because its traces are best preserved in the geological record. Its climate was similar to today but possibly a few degrees warmer and sea levels were 4-6 meters higher than today. But the precise timing of this occurrence and any variability within the interglacial interval remains poorly constrained, yet this information is important in the context of current climate change debate for understanding the sensitivity of ice sheets to changes in temperature. Field sites from which we have preliminary information include: Western and Northern Australia, the Seychelles and the Mediterranean. Earlier interglacials will also be examined including the Pliocene (~ 3 million years ago) when the global glacial-interglacial cycles were markedly different from those of the past 800,000 years.

3. *The present interglacial (the Holocene).* Ocean volumes have remained approximately constant during the past 6000 years but periodically the argument arises that large amplitude (1-2 m) changes have occurred within relatively short time periods (a few hundred years). If correct, this has major implications for the instability of the climate system when the planet is not in an ice age. There are many reasons why this question remains debated. One is of the nature of the observational evidence. Another is land movement caused by tectonic and global dynamic processes. A third is the ongoing interaction between the past ice sheets and the solid earth and oceans. We will address these issues to arrive at what we hope will be a definitive answer to the question of sea-level (and hence climate) stability

The research plan

The funding will enable a research associate to be appointed for about 2 years to work on the modelling aspects of the various components. The individual will be expected to have experience in the field so as to be able to build on past work so that the appointment may be at a mid-career level.

Funding will also be directed at field oriented projects by young researchers who are already engaged in aspects of sea-level studies (late stage PhDs and post-doctoral fellows). These projects will focus on specific scientific targets that bring together the young researcher(s) and researchers with experience in the selected field environment, in the requisite laboratory methods and in computational methods. These researcher would be expected to carry out preparatory work of examining existing information; of participating in field work and laboratory analyses where appropriate; and contribute to the geophysical modelling and interpretation. Two short-term appointments have already been made.

Ms Ye-Ying Sun from the University of Hong Kong (UHK) is presently working as a Balzan Student at the Australian National University (ANU), compiling and analysing sea-level data from South East Asia, extending from Malaysia to Japan, and learning the elements of geophysical modelling. She will be funded by UHK when she returns there.

Dr Helene Rouby, from France, has been appointed a Balzan Postdoctoral Fellow for four months to address the third of the above topics. She is currently also at ANU but will also spend two months at the Ecole Normale Supérieure in Paris to work on rheological problems. This position is seen as a bridge to a longer-term appointment in France. In addition, the Balzan Research Associate will be appointed before the end of 2013. Funding the laboratory work of a student to work on the sea-level signal contained in submerged speleothems from the Italian coast is currently under consideration and in June 2013 there will be a meeting with young researchers in Athens to examine a possible research program on sea-level change in Greece with its ramifications for archaeology. Finally new field projects involving young researchers in Australia are being examined. These projects will be gradually introduced over the next twelve months to avoid 'overload' and to enable supporting funding to be sought where possible.

Sea level is an important component of the four-yearly Intergovernmental Panel on Climate Change assessment of the science of climate change. The Final Draft of the Working Group 1 report was delivered in May 2013. It highlights many of the important questions for which better answers are required. It is expected that via the Balzan Foundation inspired research, the project will be able to contribute significantly to this in time for the next assessment.

Reinhard Strohm, Emeritus Professor of Music, University of Oxford, and Emeritus Fellow of Wadham College, Oxford, was awarded the 2012 Balzan Prize for Musicology *for his extensive research on the history of European music within the cultural and socio-historical context from the late Middle Ages to the present, and for his detailed descriptions of vocal music, especially early sacred music in Flanders, and of the works of Vivaldi, Handel and Wagner.*

Towards a Global History of Music

This research project aims to promote post-European historical thinking. The project is not meant to create a universal (or global) history by itself, but to take some steps towards this by exploring historical interactions between Western thought and that of other musical cultures. It looks beyond Europe but keeps Western traditions in mind as a field of reference.

Research themes

- (a) Musical interactions in the Mediterranean world, c. 300 - c. 1500;
- (b) Music in colonies, missions and trade stations, c. 1500 - c. 2000;
- (c) From utopia to ethnomusicology: theories and speculations about the evolution of music in different cultures;
- (d) Intercontinental, post-denominational Bach: the global dissemination of his music.

Institutions involved:

Faculty of Music, Oxford University;

Department of Music, King's College, University of London;

Institut für Musikwissenschaft, Universität Zürich;

Musicology Department, Faculty of the Humanities, The Hebrew University, Jerusalem;

Institut für Musikwissenschaft, Universität Wien;

Institut für Musikwissenschaft und Medienwissenschaft, Humboldt-Universität zu Berlin.

Research Programme

The project will employ twelve Research Lecturers, appointed to carry out specific individual projects during a stay of not more than one semester's length at one of the six participating institutes. These appointments may be visitorships (the appointee

comes from outside the institute) or buy-outs (the appointee is a member of the institute, temporarily released from other duties). Research Lecturers should preferably be mid-career, from post-doctoral to associate professorial status.

The main task of the Research Lecturer will be to prepare a specific research project during the stay at one of the participating institutes. They will hold at least one workshop on the topic of their research in which interested post-graduate or post-doctoral students are invited to present papers. The Research Committee will award a prize of SFr 2000 for the best student/post-doctoral essay presented in the context of a workshop and submitted by the end of the respective academic year.

The project results will be published in two volumes, comprising a) the research papers and student essays pertaining to the individual lectureships, and b) the papers of the final conference and any other larger contributions from project members.

In addition to the workshops held within the context of individual Research Lecturer tenures, other conferences and meetings will be held.



Achille Casanova, Salvatore Veca, David Baulcombe, Ronald Dworkin, Kurt Lambeck and Reinhard Strohm (from left to right).



Awards Ceremony, the Quirinal Palace, Rome, 14.11.2012, hosted by the President of the Italian Republic.



The Chairman of the International Balzan Foundation "Prize", Bruno Bottai (left), and the Chairman of the General Prize Committee, Salvatore Veca (right).



Alberto Quadrio Curzio, with on his right Salvatore Veca and on his left Salvatore Califano.



The 2012 Prizewinners: David Baulcombe, Ronald Dworkin, Kurt Lambeck and Reinhard Strom (from left to right).



Members of the General Prize Committee: Antonio Padoa Schioppa, Gottfried Scholz and Karlheinz Stierle (first row, from left to right).



The 2012 Balzan Prizewinners' Interdisciplinary Forum, the Hall of Natural Sciences, Accademia Nazionale dei Lincei, Rome, 15.11.2012.

Profiles

The International Balzan Foundation

The *International Balzan Foundation “Prize”* aims to promote, throughout the world, culture, science, and the most meritorious initiatives in the cause of humanity, peace and fraternity among peoples, regardless of nationality, race or creed. This aim is attained through the annual award of prizes in two general fields: literature, the moral sciences and the arts; medicine and the physical, mathematical and natural sciences.

Nominations for the prizes in the scientific and humanistic fields are received at the Foundation’s request from the world’s leading academic institutions. Candidates are selected by the *General Prize Committee*, composed of eminent European scholars and scientists. Prizewinners must allocate half of the Prize to research work, preferably involving young researchers.

At intervals of not less than three years, the Balzan Foundation also awards a prize of varying amounts for humanity, peace and fraternity among peoples.

The *International Balzan Foundation “Prize”* attains its financial means from the *International Balzan Foundation “Fund”* which administers Eugenio Balzan’s estate.

The Accademia Nazionale dei Lincei

The *Accademia Nazionale dei Lincei*, founded in 1603 by the Roman-Umbrian aristocrat Federico Cesi and three other young scholars, Anastasio De Filiis, Johannes Eck and Francesco Stelluti, is the oldest scientific academy in the world. It promotes academic excellence through its Fellows whose earliest members included, among many other renowned names, Galileo Galilei.

The Academy’s mission is “to promote, coordinate, integrate and disseminate scientific knowledge in its highest expressions in the context of cultural unity and universality”.

The activities of the Academy are carried out according to two guiding principles that complement one another: to enrich academic knowledge and disseminate the fruits of this. To this end, the *Accademia Nazionale dei Lincei* organises national and international conferences, meetings and seminars and encourages academic cooperation and exchange between scientists and scholars at the national and international level. The Academy promotes research activities and missions, confers awards and grants, publishes the reports of its own sessions and the notes and records presented

therein, as well as the proceedings of its own conferences, meetings and seminars.

The Academy further provides – either upon request or on its own initiative – advice to public institutions and when appropriate drafts relevant reports. Since 1992, the Academy has served as an official adviser to the President of the Italian Republic in relation to scholarly and scientific matters.

The Swiss Academies of Arts and Sciences

The Association of the *Swiss Academies of Arts and Sciences* includes the Swiss Academy of Sciences (SCNAT), the Swiss Academy of Humanities and Social Sciences (SAHS), the Swiss Academy of Medical Sciences (SAMS), and the Swiss Academy of Engineering Sciences (SATW) as well as the two Centres for Excellence TA-SWISS and Science et Cité. Their collaboration is focused on methods of anticipating future trends, ethics and the dialogue between science, the arts and society. It is the aim of the *Swiss Academies of Arts and Sciences* to develop an equal dialogue between academia and society and to advise Government on scientifically based, socially relevant questions.

The academies stand for an open and pluralistic understanding of science and the arts. Over the long-term, they mutually commit to resolving interdisciplinary questions in the following fields:

- They offer knowledge and expertise in relation to socially relevant subjects in the fields of Education, Research and Technology.
- They adhere to the concept of ethically-based responsibility in gaining and applying scientific and humanistic knowledge.
- They build bridges between Academia, Government and Society.

Agreements on Collaboration between the International Balzan Foundation “Prize”, the Accademia Nazionale dei Lincei and the Swiss Academies of Arts and Sciences

(Hereafter referred to as the ‘Balzan’, the ‘Lincei’ and the ‘Swiss Academies’, respectively)

The main points of the agreements between the Balzan, the Lincei and the Swiss Academies are the following:

1) The promotion of the Balzan Prize and the presentation of the Prizewinners through the academies’ channels of communication, in Italy and Switzerland as well as abroad. By virtue of the relations of the Lincei and the Swiss Academies with academies of other countries and with international academic organizations, they will contribute to more widespread circulation of news related to the Balzan;

2) On the occasion of the Awards ceremony of the Balzan Prize, held on alternating years in Rome and Berne, each academy will contribute to the academic organization of an interdisciplinary Forum, in the course of which the Prizewinners of that year will present their academic work and discuss it with other academics proposed by the academies. Furthermore, in the years when the ceremony is held in Rome, one of the Prizewinners will give a Balzan Lecture in Switzerland, and when the ceremony is held in Berne, a Balzan Lecture will be organized at the headquarters of the Lincei in Rome;

3) The academies will contribute to a series of publications in English (ideally with summaries in Italian, German and French), created by the Balzan, with the collaboration of the Balzan Prizewinners.

To promote and supervise all these initiatives, two Commissions have been set up, one between the Balzan and the Lincei (composed of Professors Sergio Carrà, Lellia Cracco Ruggini and formerly Claudio Leonardi†, now Carlo Ossola) and another between the Balzan and the Swiss Academies (composed of its President originally Professor René Dändliker followed by Professor Peter Suter, then Heinz Gutscher and now Thierry Courvoisier, Dr. Markus Zürcher and Professor Meier-Abt). Both commissions are chaired by Professor Alberto Quadrio Curzio as a representative of the Balzan, which is also represented by Professors Enrico Decleva and Paolo Matthiae, while the Balzan Secretary General, Dr. Suzanne Werder, has been appointed Secretary of both Commissions.