Crafoord Prize *Symposia*

26 April 2007

THE CRAFOORD PRIZE IN

Geosciences 2006

AND THE CRAFOORD PRIZE IN

Biosciences 2007

Astronomy
Mathematic[s] &
Geosciences
Biosciences
Polyarthritis

Content

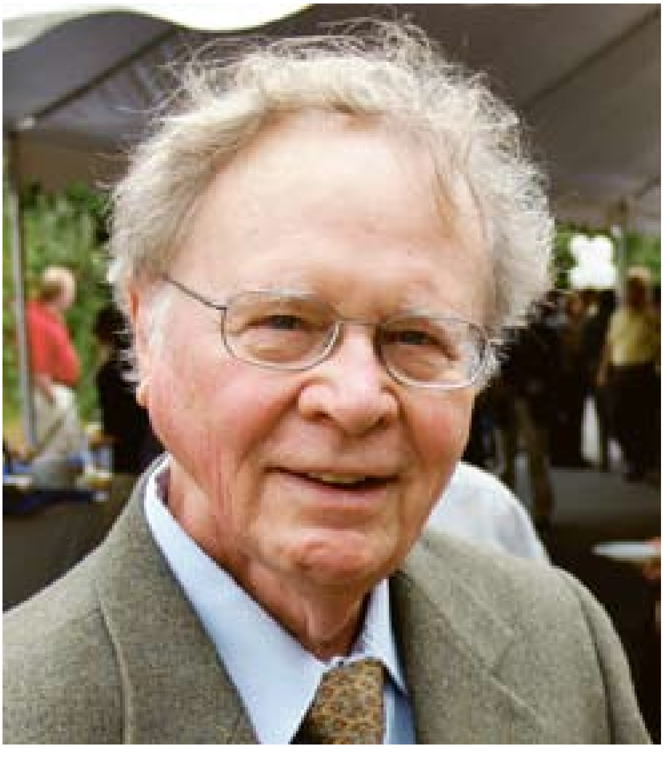
Programme

26 April

Palaestra

	Moderators: David Gee, Uppsala University, Sweden and Svante Björck, Lund University, Sweden	
9.00	*Carbon and climate*	***Wallace Broecker*, Lamont-Doherty Earth Observatory, Columbia University, USA. Crafoord Prize Laureate 2006.**
10.15	**Coffee break**	
10.45	*Pleistocene records of marine chemistry and atmospheric CO_2*	***Bärbel Hönisch*, Lamont-Doherty Earth Observatory, Columbia University, USA**
11.20	*Terminations*	***George Denton*, University of Maine, USA**
12.00	**Discussion**	
12.30	**End of symposium**	

Crafoord Laureate 2006



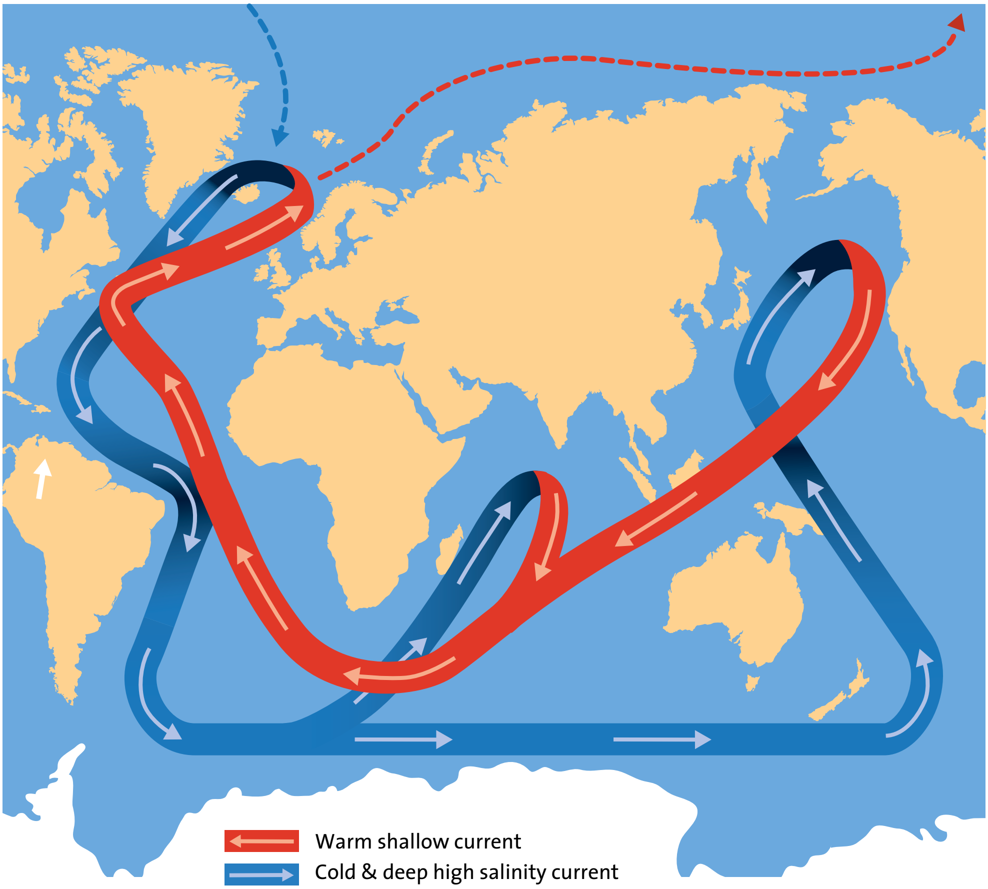
Wallace Broecker

Born 1931 in Chicago.
PhD in Geology 1958 from Columbia University.
Newberry Professor of Earth and Environmental Sciences at Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA.

"for his innovative and pioneering research on the operation of the global carbon cycle within the ocean – atmosphere – biosphere system, and its interaction with climate"

Climate change and "the great unplanned carbon dioxide experiment"

WILL TODAY'S GROWING greenhouse effect lead to major climate changes and how cautious do we have to be? To answer these questions we have to understand the processes governing the interaction between the atmosphere, the oceans, ice and living organisms. Geochemist Wallace Broecker is the person who has contributed most to our knowledge of this complex interactive system. His most pioneering contribution was his study of the global carbon cycle. Previously the composition of seawater was explained, for example, in terms of chemical equilibrium. A good 35 years ago Broecker launched instead a flow model based on the interaction of land, atmosphere and the oceans. In doing so he has made a decisive contribution to our understanding of the link between carbon dioxide levels



in the atmosphere and the chemistry of the oceans, for example how much carbon dioxide they can receive and store. The laureate has also played a crucial role in developing the theory of large-scale ocean currents and matching it with the interactive Earth System. He was 20-30 years ahead of his time when, in the 1960s, he suggested that rapid climate changes during the last glacial cycle were related to alterations in global ocean circulation patterns.

Ocean currents distribute heat between latitudes and, when they change, it has major effects on the climate, both locally and globally. For example if warm surface water failed to reach as far north in the North Atlantic as it does today, the climate in Scandinavia could be similar to Alaska's. Applied to the current climate debate, paradoxically, rapid global warming and increased rainfall could lead to a colder climate around the North Atlantic.

Broecker participates actively in the on-going debate, providing information about the interactive Earth System to the general public, politicians and other decision makers. He does not prophesy doom but urges caution: one of his similes is a comparison of the complex climate system with a sleeping dragon that we should not disturb.

Carbon and Climate

WALLACE S. BROECKER
LAMONT-DOHERTY EARTH OBSERVATORY OF COLUMBIA UNIVERSITY, USA

I BEGAN MY CAREER in science in the summer of 1952 as a helper in Columbia University's radiocarbon dating laboratory. Fifty-five years later, I'm still at Columbia and still involved in radiocarbon measurements. However my interests have widened to include carbon dioxide in the atmosphere and carbonate ion in the deep sea. Along the way it occurred to me that the Greenland ice core record was telling us that the earth's climate system must, in a sense, be quantized. During the last glacial period, sudden reorganizations in the ocean's thermohaline circulation led to abrupt (decades) and global scale shifts in temperature and rainfall. Coming to grips with why these occurred in the past and whether the ongoing manmade increase in CO_2 might lead to yet another such reorganization has dominated my thinking during the last two decades. As a consequence, I have become a strong advocate of action to stem the emissions of this greenhouse gas.

Pleistocene records of marine carbonate chemistry

BÄRBEL HÖNISCH
LAMONT-DOHERTY EARTH OBSERVATORY OF COLUMBIA UNIVERSITY, USA

ICE CORE RECORDS of atmospheric pCO_2 are restricted to the late Pleistocene glacial cycles. Because carbon dioxide is well mixed in the atmosphere, and because CO_2 is exchanged between the surface ocean and the atmosphere, knowledge of past sea surface carbonate chemistry can place constraints on past atmospheric pCO_2. A promising candidate for reconstructing marine carbonate chemistry is the boron isotope proxy for past seawater pH. In order to use the proxy with confidence, however, all other controls apart from pH need to be thoroughly understood. Recent laboratory and sediment experiments have demonstrated that vital effects and partial shell dissolution have the potential to modify the primary seawater pH signal recorded in the boron isotopic composition of planktic foraminifers but it has also been suggested that careful sample selection allows for avoiding potential complications.

Following strict criteria of sample selection and analysis, we now have convincing evidence that surface seawater pH reflects variations in atmospheric pCO_2 across late Pleistocene glacial cycles. A remarkable match between boron isotope estimates and the Vostok ice core bears this out and confirms that glacial surface ocean pH was ~0.2 units higher compared to interglacials.

We are now in the process of extending the marine record to the early Pleistocene (~1.8 Ma BP), when the periodicity of glacial cycles was dominated by the 41-kyr obliquity forcing. Because the 100-kyr periodicity of eccentricity is by far the weakest solar insolation forcing, the dominance of this periodicity in the late Pleistocene cycles remains an enigma. It has been suggested the 'mid-Pleistocene transition' may be due to global cooling, possibly caused by a long-term decrease in atmospheric CO_2 concentrations. Direct evidence for such a decrease, however, has not yet been demonstrated. Our new boron isotope data suggest the pre-transition glacial/interglacial surface seawater pH amplitude was smaller compared to the late Pleistocene but the average G/I pH before and after the transition are similar. Our data thus do not support the hypothesis that a longterm pCO_2 decrease was the primary driver of the transition.

Terminations

GEORGE H. DENTON
CLIMATE CHANGE INSTITUTE AND DEPARTMENT OF EARTH SCIENCES, UNIVERSITY OF MAINE, USA

THE CAUSE OF THE ICE AGES that dominated earth history during the past million years remains a major scientific mystery. Orbital changes can account for the relatively minor oscillations superimposed on each ice age. But the primary asymmetrical glacial signature, with a pacing near 100.000 years, remains unexplained. Each 100.000-year ice age features long and gradual cooling that culminates in a pronounced glacial maximum. In each case this maximum ends with a termination that brings the glacial cycle to a close. Here I search for clues about the cause of terminations by examining the global sequence of events at the end of the last ice age. Improved knowledge of terminations can afford insights into the vexing question of what drives 100.000-year glacial cycles.

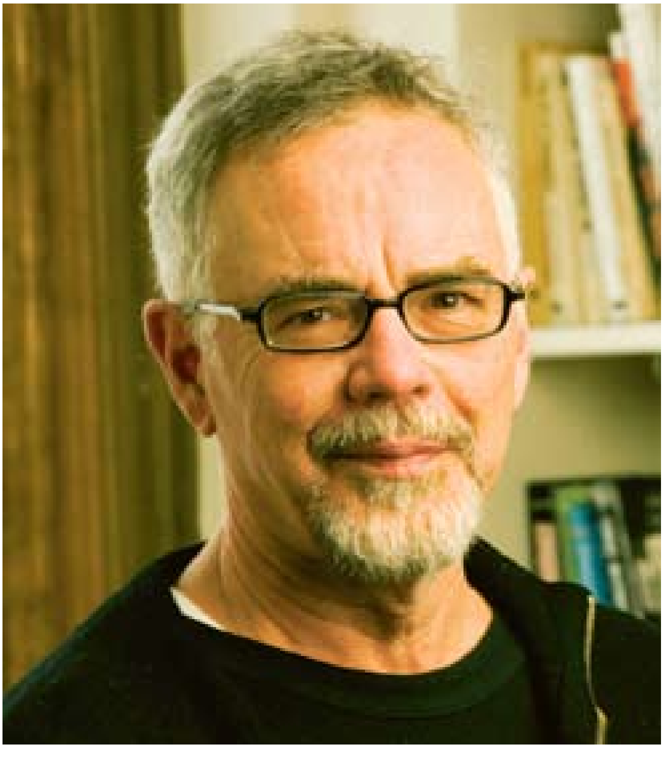
Programme

26 April

Kulturen

	Moderator: Lotta Kvarnemo, Göteborg University, Sweden	
9.00	*Natural selection and social theory*	***Robert Trivers*, Rutgers University, New Brunswick, USA**
10.00	**Coffee break**	
10.30	*Parental investment and sexual selection*	***Tim Clutton-Brock*, University of Cambridge, UK**
11.30	*Genomic imprinting and social behaviour*	***David Haig*, Harvard University, Cambridge, USA**
12.30	**End of symposium**	

Crafoord Laureate 2007

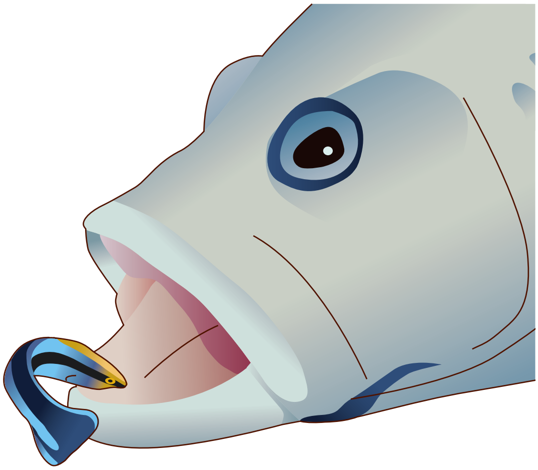


Robert L. Trivers

Born 1943 in Washington DC. PhD in Biology 1972 at Harvard University, Cambridge, MA, USA. Professor of Anthropology and Biological Sciences at Rutgers University, New Brunswick, NJ, USA.

"for his fundamental analysis of social evolution, conflict and cooperation"

Social evolution in the animal world—conflict and cooperation



IN THE EARLY 1970s, Robert L. Trivers presented pioneering thoughts on the evolution of the social behaviour of animals. These thoughts form the basis today of large parts of sociobiology, which investigates the origin of cooperation and conflict in the animal world.

Right up to the 1960s, thoughts on the evolution of the social behaviour of animals were rather undeveloped. Darwin proposed several hypotheses concerning social evolution in his time, but these ideas were not picked up by his successors. That is why this subject has had a dormant existence for a century.

This year's Crafoord Prize Laureate in biosciences, Robert Trivers, is one of the small group of pioneering scientists who began to ponder on the social behaviour patterns of animals and how they might have arisen through evolution. Between 1971 and 1976, he launched five ideas that have been of the greatest importance for the development of sociobiology. They have inspired many behavioural ecologists, who have to a large extent confirmed Trivers' ideas.

The first problem he focused on was how evolutionary theory could explain cooperation between individuals that are not related. Trivers concluded that cooperation of this kind can only develop if the animals cooperate over a long period of time and if they are able to recognise each other. This idea had an immediate and great impact and Trivers' thoughts have later been developed by game theoreticians, among others.

Trivers' second bid idea deals with the way in which the traits of male and female animals are influenced by their investment in their offspring. In a species where the female is responsible for most of the care, the male will develop traits that the female likes, for example, colourful plumage, attractive song or an impressive body size. If the females do not like the male, he will have poorer chances of passing his genes on to the next generati on.

A third hypothesis presented by Trivers is the explanation of why certain species sometimes give birth to more young of the same sex. He argued that it could be advantageous, for example, for a female to give birth to sons when she was in good condition, since the sons usually grown bigger than the daughters and therefore demand more energy.

Trivers also explained why conflicts often arise between older young and their parents. This is not something that only occurs in teenage families. His interpretation is that when the young are old enough to take care of themselves, the parents gain by saving their care for younger or future young. The older young, on the other hand, want to benefit from their parents' care as long as possible.

The fifth idea for which Trivers has been awarded the Crafoord Prize concerns social hymenoptera: ants, bees and wasps. He predicted that the workers in an ant community, which are always female, may be expected to invest three times the amount of resources in bringing up their sisters than their brothers. When Trivers later investigated the situation in reality, the results indicated that he had been right, which later research also confirmed.

Thus, together with the previous Crafoord Laureates William D. Hamilton, George C. Williams, Edward O. Wilson and John Maynard Smith, Robert Trivers has laid the theoretical foundations for research on the evolution of social behavioural patterns in animals, a field that is known today as sociobiology and which is a part of the larger field of behavioural ecology.

Natural selection and social theory

ROBERT L. TRIVERS
RUTGERS UNIVERSITY, USA.

MANY HUMAN DISCIPLINES produce social theory—e.g. economics and cultural anthropology—but none of these has a secure foundation in underlying knowledge. (In economics we are supposed to maximize our 'utility' where utility is anything we wish to maximize.) Evolutionary biology provides a foundation, with natural selection the key concept: all organisms evolve so as to attempt to maximize their own genetic contribution to future generations, measured mostly in offspring but also in effects on other relatives appropriately devalued.

Cooperation between distantly related individuals can also evolve under a broad range of conditions, contingent often on a tit-for-tat style of rewarding good with good and evil with resistance, a system that appears to have generated our sense of fairness, which can, in turn, be measured quantitatively by economic games across individuals and cultures.

A unified body of social theory permits us to combine sub-theories to good effect. For example, sex ratio and sexual selection theory suggest that human society operates with a female-bias at the bottom and a male bias at the top. This was first revealed by sex ratio biases and then confirmed with demographic, behavioral and genetic evidence.

Social theory based on natural selection leads us to expect internal genetic conflict, because different genetic elements are inherited according to different rules and genes can sometimes directly improve their transmission to the next generation at the expense of the larger organism. This has led to a vast world of within-individual genetic conflicts that evolve in parallel (and interaction) with the social life of individuals.

A mature social theory is one that has a theory of falsehood—in this case, of deceit and self-deception. We appear actively to deceive our own conscious minds, the more effectively (and efficiently) to fool others. These tendencies are especially strong in out-group relations and make a disproportionate contribution to human-generated disasters such as warfare. Israel's most recent assault on Lebanon nicely illustrates this principle, as well as the fact that inbreeding tends to promote inter-group hostility. Analysis of religions and the ideologies they promote must include their effects on the breeding structure of human populations. In general, it seems desirable (and somewhat overdue) for social theory based on natural selection to enrich our understanding of human social problems.

Parental investment and sexual selection

TIM CLUTTON-BROCK
UNIVERSITY OF CAMBRIDGE, UK

BOB TRIVERS' CONCEPT of parental investment revolutionised our understanding of the causes of intrasexual competition and of the evolution of sex differences in morphology, behaviour and survival. Building on Bateman's observation that variance in breeding success was greater in males than in females, Trivers' 1972 paper, now familiar to all students of evolutionary biology, provided the first coherent framework explaining why this was the case and why males generally compete more intensely for mating partners than females. Trivers argued that males invest less in their progeny than females so that access to females is the usual factor limiting the breeding success of males, who consequently compete more intensely for mating opportunities than females. Combined with empirical evidence that male competition is generally more intense in polygynous than monogamous species, this simple principle provides a framework for explaining the distribution of sex differences in the intensity and frequency of aggression and in the extent of mate selection, as well as in body size, growth and in the development of weaponry and other secondary sexual characters. The same framework helps to account for sex differences in juvenile survival and adult longevity and, by extension, for the distribution of sex differences in dispersal and the evolution of strategies for avoiding inbreeding with close relatives. In addition, it makes important predictions concerning the effects of parental characteristics on the relative fitness of sons and daughters and on optimal sex ratios. The implications of Trivers' theory extend far beyond evolutionary biology, generating important insights in population dynamics, epidemiology and conservation biology.

While empirical research has confirmed the generality of relationships between relative parental investment and sex differences in behaviour and morphology, there are important exceptions which are still being explored. Some are more apparent than real and either support the predictions of Trivers' theory or stem from the misleading assumption that the reproductive competition between males generates similar selection pressures in different species. However, in a number of animals where females invest more heavily in their offspring than males, the relative intensity of reproductive competition in the two sexes varies throughout the reproductive cycle or changes with resource availability while, in a few, females typically compete more intensely with each other than males and show unusual secondary sexual characters associated with reproductive competition. Recent studies suggest that, in several of these species, the resources necessary for successful reproduction in females are heavily concentrated, generating intense intrasexual competition between females for breeding opportunities and a reversal of the usual pattern of sex differences in behaviour and morphology. These cases emphasise the need to understand the causes and consequences of reproductive competition in females as well as in males and the extent to which they affect the evolution of sex differences.

Genomic imprinting and social behavior

DAVID HAIG
HARVARD UNIVERSITY, USA

AN INDIVIDUAL'S RELATIVES can be classified as symmetric kin (with equal probabilities of carrying copies of the individual's maternally and paternally derived genes) and asymmetric kin (with unequal probabilities). Inclusive fitness theory has traditionally dealt with the problem of asymmetric kin by employing a coefficient of average relatedness (on the implicit assumption that maternally and paternally derived alleles are constrained to have the same effects). However, if this assumption is relaxed, asymmetries of kinship create the possibility of internal conflicts within individuals over the performance of social behaviors (broadly defined). Conflicts arise because behaviors that increase an individual's matrilineal inclusive fitness may differ from behaviors that increase an individual's patrilineal inclusive fitness. Such conflicts provide a plausible explanation for the evolution of genomic imprinting (gene expression that differs when a gene is maternally and paternally derived). Two factors that can give rise to the kinds of relatedness asymmetries that favor genomic imprinting are multiple paternity of a female's offspring, which favors paternally expressed genes in fetuses that extract more resources from mothers, and sex-biased dispersal, which causes group members to have different degrees of matrilineal and patrilineal kinship and may result in an internal conflict over the relative benefits of selfish and altruistic acts.

THE Crafoord PRIZE

www.crafoordprize.se

THE ROYAL SWEDISH ACADEMY OF SCIENCES is an independent, non-governmental organisation whose aim is to promote the sciences and strengthen their influence in society. Traditionally, the Academy takes a special responsibility for the natural sciences and mathematics, but in its work it strives to increase exchanges between different disciplines.

The activities of the Academy are aimed mainly at:

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- stimulating interest in mathematics and the natural sciences in schools
- spreading scientific and popular-scientific information in various forms
- offering unique research environments and
- maintaining contact with foreign academies, learned societies and other international scientific organisations
- representing the sciences in society
- carrying out independent analyses and evaluations, based on scientific grounds, of issues of importance for society

The 400 members of the Academy are active within Classes and Committees. Its members initiate investigations, responses to government proposals, conferences and seminars. Once a month the Academy holds a General Meeting and in connection with this and on one other occasion each month it arranges public lectures. (For more information, please see www.kva.se.) The Academy's own institutes offer unique research environments for climate research, botany, ecological economics, the history of science, astrophysics, mathematics, marine biology and other subjects. The Academy awards annually a number of prizes, the best known of which are the Nobel Prizes in Physics and Chemistry and the Sveriges Riksbank Prize in Economic Sciences in memory of Alfred Nobel. Other important prizes are the Crafoord Prize, the Söderbergska Prize and the Göran Gustafsson Prizes. The latter are awarded to outstanding young researchers and are a unique combination of a personal prize and a research grant. The Academy also supports researchers who have been researching actively for five to ten years after taking their doctorate by providing a salary for five years through the support of external foundations. Through its various Committees the Academy also works for the development of a society based on scientific grounds. Great interest is paid to educational issues and a major school development program, NTA (Natural Sciences and Technology for All), is organised in collaboration with the Royal Swedish Academy of Engineering Sciences.

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