

RESEARCH CONFERENCES

ESF-COST High-Level Research Conference

**Complex Systems and
Changes**

**Darwin and Evolution:
Nature-Culture Interface**

Hotel Eden Roc, San Feliu de Guixols • Spain
15 - 20 September 2009

Co-Chairs: **Roland Pochet**, Université Libre de Bruxelles, BE
& **Alain Peyraube**, CNRS and EHESS, FR

Programme Committee:

Reinhart Ceulemans, Universiteit Antwerpen, BE, **János
László**, Hungarian Academy of Sciences, HU, **Martin Stokhof**,
Universiteit van Amsterdam, NL

www.esf.org/conferences/09309

Highlights & Scientific Report



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Conference Highlights

Please provide a brief summary of the conference and its highlights in non-specialist terms (especially for highly technical subjects) for communication and publicity purposes. (ca. 400-500 words)

The Conference- commemorating Charles Darwin's 200th anniversary has provided a tantalizing glimpse of the future potential of the Darwinian Paradigm.

This ambitious conference drew together speakers from both the "hard" and "soft" sciences, biological and social, to achieve the following goals

- a) Provide a summary of the successful application of a Darwinist approach within non-biological disciplines
- b) Highlight insights from other disciplines in understanding biological evolution
- c) Explore the potential for developing hybrid domains

Over a period of 5 days, leading researchers and practitioners delivered a range of cutting-edge papers, exploring these three primary aims. In addition a selection of short talks, poster sessions and round table discussion groups provided additional coverage for further topic clarification and debate.

Delegates at the ESF-COST conference heard how principles of evolution and natural selection can and have been applied to the cognitive sciences, and to the development of language, psychology, agriculture, fisheries, history, and philosophy.

In addition, a new basis for understanding and applying evolutionary principles was argued viz – the role of "information" in understanding the core of the adaptive and speciation processes. It was demonstrated that information and related phenomena such as complexity and computability, are likely to play a central role in better interpreting biological processes and the wider application of Darwin's theory in the future.

The conference was concerned not just with theory but also solving practical problems, for example in sustainable agriculture. Great interest was generated by a paper discussing the history of plant cultivation in India. "This demonstrated the co-evolution and domestication by humans of a rich diversity of plants such as cereals in the Indian sub-continent consistent with the development of their agricultural systems and civilization in general," said Peyraube. "These plant species were originally drawn from a variety of locations outside India including the Middle East and Africa. They survived and flourished because of the compatibility of their original environments with the wide variety of local climates in the vast Indian subcontinent."

I hereby authorize ESF – and the conference partners to use the information contained in the above section on 'Conference Highlights' in their communication on the scheme.

Scientific Report

Executive Summary

(2 pages max)

The principles of evolution discovered by Charles Darwin can be applied to many complex systems and not just biological organisms. At the same time evolutionary biology can learn from the study of change in these other systems and gain new insights into how life may have come about and adapted over its 4 billion year history.

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- a) Provide a summary of the successful application of a Darwinist approach within non-biological disciplines
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The above overall goals were supported by the structure of the conference- designed to cover the following three main streams.

These included a range of presentations covering Darwinism from the biological as well as interdisciplinary viewpoint, combined with short papers, round tables and posters, providing additional coverage for further clarification and debate

Conference Streams:

Part 1- "Evolution" of Darwin's Theory

Part 2- Nature-Culture Interfaces

Part 3- Complex Systems

The application of Darwinian principles was discussed across the range of advanced biological phylogenetic applications as well as within a number of interdisciplinary and hybrid areas including:

Culture / Nature / Human Society

Language / Impairment

Psychology / Cognition

Economics / Politics

Agriculture / Fisheries

Historical / Philosophical

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Scientific Content of the Conference

(1 page min.)

- Summary of the conference sessions focusing on the scientific highlights
- Assessment of the results and their potential impact on future research or applications

Within part 1- "Evolution of Darwin's Theory", Luis Campos from Drew University provided an outline of the complex history of Darwinism, which triggered a lively discussion on the semantics of the term Darwinism—with a consensus that it can have multiple meanings and many nuances relating to its context over time.

The next two papers in this section explored the gulf between the two major theories of

evolutionary biology- modern evolutionary synthesis and Developmental systems Theory and the way natural selection acts to maintain genetic diversity within populations.

Within part 2- Nature-Culture Interfaces, Vinciane Depret from Université de Liège poses Darwin's dilemma in deciding which monkeys would be most likely to represent our ancestor among the primate families and could this be established based on a criteria of "morality"? Also how to fit the first hominid transition species into this continuum. The choice has determined the story of primatology and even impacted Freud's theories of sexuality. Eric Green from NIH provided a clear exposition of state of the art progress in DNA sequencing techniques and roadmap via the ENCODE project. A comparison of the DNA base sequences from species separated over long and short evolutionary distances, is offering a key mechanism for understanding and tracking evolution. Since completion of sequencing the Human Genome, this project has generated sequences from multiple other vertebrate species in order to understand life's evolutionary processes at a deeper level. Comparative analysis of these sequence data is now revealing important insights about patterns of sequence conservation among species and about the location of highly conserved sequences likely to be functionally important; integrating experimental and computational data and unraveling the functional and evolutionary complexities of the human genome. Bryan Clarke from Nottingham presented the Frozen Ark Project. As global warming impacts the planet over the next 50 years, at least 30% of animal and plant species will be at risk of extinction. The Frozen ark project has been initiated by the author in order that the evolutionary heritage of such species can be retained in perpetuity. It is proposed to recover a small sample of DNA from each species and store it in a safe repository at sub-zero temperatures. In the future this will be forever available for understanding that species evolutionary role in the great web of life. This project is arguably one of the most important initiatives conceived by biologists and should receive global support and acclaim. Jeffrey Hard from Northwest Fisheries Science Center considers the potential impact of human exploitation on the genetics and sustainability of wild species populations. There has been surprisingly little understanding of human-induced selection in the wild until recently. Hunting, fishing and other forms of human exploitation, in contrast with traditional forms of agriculture and aquaculture, where the most desirable individuals are selected for breeding to increase the frequency of particular phenotypes. Evolution induced by human harvesting involving for example elimination of the larger mature members, can therefore increase the risk of population collapse and might greatly increase the time it will take such over-harvested populations to recover. Mukund Kajale from Deemed University, Indian provided a review of the co-evolution and domestication by humans of a rich diversity of plants such as cereals in the Indian sub-continent, consistent with the evolution of their agricultural systems and practices. These plant species were originally drawn from a variety of locations outside India including the Middle East and Africa. They survived and flourished because of the compatibility of their original environments with the wide variety of local climates in the vast Indian subcontinent and contributed greatly to Indian civilisation. Csaba Pleh from Hungarian Academy of sciences analysed three issues: a) Continuity of mechanisms- examines several models for the nature-culture interface- variation selection stabilisation cycles interpreted through Mach, Karl Popper, Karl Buhler to Daniel Dennett's tower of selection. b) Cultural Selection models- two models are compared viz-the memetic ideas of Dawkins, which postulate conservative cultural transmission and replication and the epidemiology of representations approach of Dan Sperber who stressed the role of cognition and psychology in the spreading of culture. c) Evolutionary algorithms cultural learning using trial and error, imitation and environmental feedback- the new models of cultural learning promise a fresh interpretation of Darwinism both in neuroscience with particular evolutionary adaptations for culture and from an Evo-Devo perspective- a combination of development studies with evolutionary considerations.

Within part 3 – Complex Systems, Antoine Danchin from Institut Pasteur, Paris, gave a highly significant paper as it helps bridge the gap between applying darwinian principles to biology and to

other disciplines outside mainstream biology such as psychology, culture and economics. Information is central to biology in many ways including governing the transformation from DNA to its protein expression as well as the control of cellular processes, including processes of reproduction and replication. It is conjectured that in natural systems, selection is dependent on an information-based process which requires energy to store, edit, conserve and apply via the core genomic blueprint governing the adaptation, reproduction and replication of cells. The author conjectures that the process of Natural Selection is the process that makes room for the accumulation of such information, using energy to reverse entropy, thereby preventing the destruction of information-rich functions. Adaptive mutations show they could be manifestation of the process of accumulation of information and polyphosphate could play the role of essential energy reservoir. An analogy is drawn with the process of information regeneration using Maxwell's demon – a hypothetical system that can reverse the randomness or entropy of gas molecules using an information process. Hans Liljenstrom from Swedish University of agricultural Sciences provides additional insight into one of the great mysteries of evolution- the increasing complexity of the brain and nervous system of animals over time, from simple multi-cellular organisms to vertebrates, fish, land animals, lizards, dinosaurs, mammals, primates and humans. This trajectory has continued despite the dead ends and discontinuities of millions of species. The author suggests that the resulting evolutionary adaptive pathways have been conserved as information at the molecular and cellular level in genetic and epigenetic structures over generations. The evolution of complexity is discussed, focusing on the evolution of the nervous system- its structure, dynamics and function, which is seen a major transition in biological evolution and allows for an increasing capacity for information storage and processing, increasing chances of survival. Both cognition and consciousness depend on the architecture and complexity of the organism. Cognition is understood as neural knowledge processing and shows the same features as non-neural adaptive processes, while consciousness might be seen as an emergent evolutionary process. Arcadi Navarro from reviews the foundations and potential of geno-economics, which is based on the economics of cooperation- a key principle of Darwinism. Cooperation for the common good of the group is hard wired cognitively in all species – including humans, bacteria and insect colonies. There have also been discovered gene variants associated with behavioral traits- 80% of traits have genetic origins- such as those affecting economic/risk decisions as verified in game theory. Such socio-economic traits maximize rational, self-benefiting behavior in humans.

Forward Look

(1 page min.)

- *Assessment of the results*
- *Contribution to the future direction of the field – identification of issues in the 5-10 years & timeframe*
- *Identification of emerging topics*

The conference has successfully and seamlessly woven together the many strands required for an outstanding success including- developing the three main themes of the conference while at the same time successfully fulfilling its primary aims of exploring the scope and potential of the Darwinian Paradigm. This required bringing together not only leading researchers in the major disciplines of evolutionary biology, but providing the right balance and flow of supporting roundtable discussions and short talks together with a variety of sophisticated poster sessions. The basis therefore has now been successfully laid for a series of specialist conferences, examining in detail the application of the Darwinian/Evolutionary paradigm to a variety of non-biological disciplines and technologies. The feedback from this interplay is also likely to be of significant value to those working in the biological field by providing possible alternate research paths and methodologies.

By its choice and quality of paper selection, this ESF-COST conference has succinctly captured the excitement and momentum now building within the wider scientific and general community; predicting a much more comprehensive role for the application of Darwin's ageless evolutionary principles in the future. Within the final discussion it was suggested that

- a) Different workshops should be organized
- b) The Frozen Ark project would fit with a COST action

The benefits of the conference will emerge in both the scientific and public domains. From a science perspective, the conference provided a plethora of highly original and valuable contributions to the research literature. For example, a number of papers dealt with applications applying Darwinian principles to interdisciplinary fields such as psychology, culture and the economy as well as the role of information and complex adaptive systems in natural selection-meeting the primary aims of the conference. In addition these contributions have defined a roadmap for future Darwin conferences, based on exploring specific interdisciplinary fields that show promise in the application of general evolutionary principles. From the public perspective this conference has certainly proved a landmark event worthy of Darwin's Bi-centenary celebration, by providing a clear indication that research is moving towards defining a deeper paradigm for the application of Darwinian principles. This will result in greater public awareness of Darwin's contribution to science and civilisation's progress, guaranteeing increased ongoing support for the funding of evolutionary research and development projects.

- Is there a need for a foresight-type initiative?
-

Atmosphere and Infrastructure

- *The reaction of the participants to the location and the organization, including networking, and any other relevant comments*

The Hotel Eden Roc proved an outstanding venue, with stunning ocean cliff views, pool and BBQ facilities as well as excellent all round service; providing many opportunities for delegates to extend their discussions and friendships in a very friendly atmosphere. In addition all delegates greatly enjoyed the social program, including informal visits to the local village, excursion to Girona, conference dinner and flamenco dance exhibition.

Bryan Clarke reaction: Dear Roland, Many thanks for a very good meeting in delightful surroundings. It was pleasure to meet so many interesting people. I shall try to keep in touch with several of them, yourself included.