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Review 2014 and Structure of the KLI

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Das KLI setzt einen internationalen Standard im Hinblick auf eine zukunftsweisende interdisziplinäre Grundlagenforschung – ein geradezu idealer Ort für Wissenschaftler, die an der Vorfront der Entwicklung ihrer jeweiligen Disziplinen arbeiten.

The KLI sets international standards concerning a forward-thinking interdisciplinary basic research – the ideal place for researchers working at the forefront on the development of their respective disciplines.

Kurt Dopfer, University St. Gallen

1.1 The Year in Review

2014 was a year of vibrant activities at the KLI – yet clouded by an incident of grief and mourning.

At the beginning of the year, the KLI moved from the Lorenz mansion in Altenberg to its new premises in Klosterneuburg. The move was exciting, because for the first time since the founding of the KLI, a space specifically designed for the needs of an independent center of advanced study could be occupied. Whereas we lost the aura of a famous location in the history of ethology, we gained the facilities of a real institute, with ample room for the realization of the KLI's goals and substantial opportunities for future expansion. The building ideally combines historical charisma with the functional benefits of modern architecture. At the same time, the institute has moved closer to the cultural and academic institutions of Vienna and can now be reached rapidly and easily by public transport. Charming Klosterneuburg provides the necessary infrastructure for our fellows and guests, and yet the new site offers an aura of peace for intellectual thought. Everybody taking part in the move or visiting the new institute immediately felt inspired.

Everything seemed to fall into place in a harmonic way, but – tragically and incomprehensibly – in November 2014, Werner Callebaut, the Scientific Director of the KLI, unexpectedly passed away. This shocking event left a deep void not only at the institute, but also at the scientific community at large. Werner's funeral was a demonstration of his profound effects on the scientific, organizational, and personal matters of the KLI. He is deeply missed by the staff and fellows of the KLI.

After Werner´s passing, the KLI and Springer had to act quickly in finding a replacement for his role as editor-in-chief of the journal *Biological Theory*, to which he had devoted so much of his time and which he had brought to international success. We are pleased and grateful that Stuart Newman from the NYMC, a long time supporter and external faculty member of the KLI, has agreed to take on the role of editor-in-chief. He will be ensuring the continuation of the journal´s high level of quality. We are also optimistic that the search for a new scientific director will be successful during the year of 2015.

Four major events and several smaller scientific activities were hosted by the KLI in 2014. The first event to take place in the seminar room of the historical building was the 30th Altenberg Workshop in Theoretical Biology on "Quality & Quantity." Three other events, the 31st Altenberg Workshop on "The Origins and Consequences of Multicellularity", an art performance entitled "Theory of Flight", and the 3rd European Seminar in the Philosophy of the Life Sciences (EASPLS) took place in the spacious lecture hall of the new wing. The KLI also co-organized the 5th Meeting of the European Society for Evolutionary Developmental Biology (EED) at the Campus of the University of Vienna, which brought together nearly 600 scientists and students from all over the world. And together with the Austrian Academy of Science, the KLI organized the symposium "Hundert Jahre Biologische Versuchsanstalt," an event that generated a lot of media attention.

All other traditional activities of the KLI were equally pursued, such as the publication of four issues of the journal *Biological Theory*, the organization of 16 KLI Colloquia, as well as an external workshop on "Explaining Development" in collaboration with the Istituto Veneto di Science, Lettere ed Arti. 17 fellows were hosted, 32 original papers published, and 65 scientific presentations were given at international meetings. The details of these projects can be found in this report.

At this point I would like to express my gratitude to all those who contribute to the KLI´s high standing within the international scientific community: the members of the KLI Trust, the Board of Directors, the Scientific Advisory Board, as well as the staff and fellows of the KLI. Last but not least, I would like to express our most profound gratitude to Traudl Engelhorn for her generous and continued support of the New KLI!

Gerd B. Müller
Chairman

1.2 The KLI

The KLI is an international center for Theoretical Biology. The institute commits itself to the formulation, analysis, and integration of biological theories as well as the investigation of their scientific and cultural consequences. The thematic focus is on evolutionary biology, developmental biology, and cognition.
The KLI supports interdisciplinary research projects in these areas that aim at generating models of living systems or meta-theoretical constructions of historical, philosophical, or cultural aspects of biological theories. Research at the KLI is supported by fellowships in six different categories; granting decisions are based on international peer review.

The KLI also pursues its objectives by organizing international workshops, symposia, and colloquia, and by publishing a scientific journal and a book series.

1.3 Organization of the KLI

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PROF. DR. GÜNTER WAGNER
Osborn Memorial Laboratory, Yale University, New Haven, CT

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Department of Systems Biology, Harvard Medical School, Boston, MA

PROF. DR. MANFRED LAUBICHLER
Department of Biology, Arizona State University, Tempe, AZ; Max Planck Institute for the History of Science, Berlin

PROF. DR. STUART NEWMAN
Department of Cell Biology and Anatomy, New York Medical College, Valhalla, NY

PROF. DR. D. KIMBROUGH OLLER
School of Audiology and Speech-Language Pathology, University of Memphis, TN

Scientific Projects

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The KLI offers six different types of fellowships for students, post-docs, and visiting scientists or scholars in the area of theoretical biology for a period of a few weeks up to two years. All project applications are subjected to an international review process.

2.1 Applications

In 2014, the KLI received a total of 62 applications for fellowships, 7 of these were granted for 2014 or 2015.

2.2 Writing-Up Fellowships

Lynn Chien-Hui CHIU
(August 2013 – January 2014)

Lynn Chien-Hui Chiu is a philosophy PhD student at the University of Missouri. Her dissertation project concerns the impact of organismal activities and cognitive abilities on natural selection explanations. She has a MA in philosophy from the University of Missouri and a MS in psychology from National Taiwan University, with a BS in Life Sciences from National Yang Ming University.

Niche Construction and Natural Selection

Organisms construct their ecological niches when they define, create, and alter their surrounds by their metabolism, behavior, and choices. Richard Lewontin (1983, 1985, 2000, 2001) argues from these phenomena that the metaphor of construction should replace the metaphor of adaptation in evolutionary theory. In this dissertation, I argue that the subsequent literature on "niche construction," including modeling work, merely revises and extends the adaptationist explanatory schema. This literature fails to recognize how Lewontin's constructivist views undermine adaptationism as an explanatory framework and revolutionize interpretations of "fitness," "niche," and "natural selection." The key difference between Lewontin and the mainstream view is how they interpret the adaptationist assumption that the internal mechanisms of variation are independent from the external, environmentally driven process of natural selection, with "one generating 'problems' at random with respect to the organism, the other generating 'solutions' at random with respect to the

environment" (Lewontin, 2001, p. 47). John Odling-Smee, Kevin Laland, Michael O'Brien, Peter Godfrey-Smith, and others merely focus on how organism-induced environmental changes affect evolutionary dynamics. However, this is consistent with the problem-solution metaphor if the niche-constructing organisms merely create the problems they later solve. I argue that niche construction undermines adaptationism because it implies that there is no "problem" in the environment. When each individual creates its own niche, the environment of the population consists of a myriad of individual selective environments dependent on organismic variation, and no longer constitutes a single problem for the population to solve. After analyzing how the explanatory roles of these concepts are challenged by niche construction, I develop a theoretical model based on Lewontin's original view, and apply it to different disciplines.

Sebastian MATUSZEWSKI
(December 2013 – December 2014)

Sebastian Matuszewski is a doctoral candidate at the Mathematics and BioSciences Group at the University of Vienna. He studied biomathematics at the University of Greifswald. The focus of his dissertation is on the genetics of adaptation in changing environments. The goal of his PhD project is to extend existing population-genetic models of adaptation to changing environments in multi-dimensional trait spaces, and to study the influence of various aspects (e.g. pleiotropy, genetic correlations, speed and direction of environmental change) on the adaptive process.

The Genetics of Adaptation in Changing Environments

Adaptation is central to Darwinian evolution, and it may be a key to the survival of species under the conditions of human-induced global change. Despite its importance, many

basic questions about the genetic basis of adaptation are still unresolved. This is particularly true for adaptation to gradual change, such as the rise of global temperature and atmospheric CO_2, or increase in UV radiation and the concentration of pollutants. To understand the consequences of gradual change, it is important to develop a theory with increased ecological realism. The fundamental event during adaptation is the substitution of a resident allel (i.e., gene variant) by a beneficial mutation. An important goal of current research - both empirical and theoretical - is to learn more about the statistical properties of these substitutions. In particular, much effort is being devoted to understanding the distribution of the effects of new mutations and the distribution of the subset of those mutations that go to fixation and contribute to adaptation. Knowledge of these distributions is necessary to answer seemingly simple questions, such as how many substitutions occur during a typical bout of adaptation - a few with large effects, many with small effects, or a combination of both - and whether they do so in a particular order (e.g., large ones first).

One way of addressing these questions in the context of gradual environmental change is to model adaptation with the so-called moving-optimum model. For a single evolving trait, Kopp and Hermisson showed that selection for a moving optimum produces patterns that are fundamentally different from those predicted under constant selection (i.e., after a single, abrupt change in the environment). In the first part of my PhD project, I extended their model to include multiple characters. In other words, I studied a moving-optimum of Fisher´s classical geometric model of adaptation in high-dimensional trait spaces. In constrast to existing models, this model deals with more complex, yet realistic, biological assumptions on the underlying genetic architecture, in particular genetic correlations between traits. This means that with two or more traits, these can be correlated with respect to selection, mutation or even both, allowing for a variety of different evolutionary outcomes. While it has been shown that more complex organisms pay a "cost of complexity" causing them to adapt more slowly to a single abrupt change in the environment, the generalization of the moving-optimum model to multiple traits likewise enables us to address how organismic complexity (and thereby pleiotropy) influences the

populations´ ability to adapt to a sustained environmental change.

To analyze this model, we derived analytical approximations for the adaptive process and verified them by means of computer simulations. In particular, we characterized how the fitness of mutations changes over time and obtained approximations for the statistical properties of "adaptive walks" (e.g., the average time and size of adaptive "steps"). Furthermore, we generalized results from previous studies demonstrating that the influence of various genetic and environmental factors on the properties of adaptive walks can be summarized in a single parameter that describes the degree to which adaptation is either "genetically" or "environmentally-limited". Addressing the question how the ability to adapt to changing environment depends on "organismic complexity," we obtained the unexpected result that, even though complexity makes adaptation more difficult, adaptation of complex organisms proceeds in large steps. In addition, we found that patterns of adaptation depend on correlation between traits, and found that the source of the correlations (mutation or selection) has a major effect and shapes the distribution of adaptive substitutions. The exact shape of this distribution, however, strongly depends on the speed of environmental change.

2.3 Postdoctoral Fellowships

Argyris ARNELLOS
(November 2013 – November 2015)

Argyris Arnellos was a Marie Curie Postdoctoral Fellow at the IAS-Research Centre for Life, Mind and Society (Department of Logic and Philosophy of Science, University of the Basque Country). Previously, he was a researcher and lecturer in the department of Product

and Systems Design Engineering at the University of the Aegean in Syros, Greece. His current line of research is centered on the role of the notion of autonomy in integrating constitutive and interactive aspects of multicellular organisms, with a focus on developmental regulatory mechanisms and their role in the self-construction of multicellular organizations, and in the formation of complex body plans and their resulting behaviors. His PhD was on The Emergence of Meaning in Autonomous Agents and in Artificial Environments*. He has published in several scientific journals and participated in numerous international and national conferences in the areas of autonomous and complex systems, 2nd-order cybernetics, philosophy of biology, philosophy of mind, and interactivism, design theory, artificial intelligence, and human-computer Interaction.*

Organizational Requirements and Regulation for Organismal Development and Maintenance

From an organizational perspective, organisms have the capacity to regulate and modify both their developmental processes and their interactions with the environment, while at the same time they are able to incorporate influences of the environment in their developmental and self-maintaining dynamics. They achieve this by exhibiting a developmental organization that fosters the endogenous construction of complex patterns of its own regulation, and which is brought about by the interplay between genetic, epigenetic, interactive, and environmental factors at the cellular, tissue and organismal levels. Several difficulties appear when one tries to specify the organizational conditions and the terms in which the development and maintenance of such an organization and its evolutionary characteristics should be accounted for. The main objective of this research project is to elucidate and provide a feasible explanation of the overall relation between the developmental organization and its endogenously produced regulation in multicellular organisms. More specifically, this project aims at getting a better

understanding of: (1) the nature, form, and pattern of different types of developmental regulatory mechanisms in an organism; (2) the ways developmental regulation shapes the relation between cells (parts), groups of cells (tissues), and the organisms (wholes) in which they participate; (3) whether the concept of regulation (and which specific regulatory patterns) can be theoretically established as a general principle underlying the exportation of "organismality" from the unicellular to a meta-cellular level; (4) how the nervous system and the respective interactive and environmental regulatory factors contribute, influence, and transform the overall pattern for the regulation of development and maintenance; (5) the regulatory logic that allows for new forms of complex agency and flexible behavior.

Tudor BAETU
(March 2012 – February 2014)

Tudor Baetu holds degrees in biology and philosophy of Biology. He obtained a MSc degree in molecular biology from McGill University (2001), where he worked on a project concerning the regulation of immune responses in cancer and HIV infection. He finished his PhD in philosophy at the Université de Montréal under the supervision of Prof. Yvon Gauthier. In his dissertation (2009), he investigated the experimental constraints on the formulation and confirmation of hypotheses, using genetics as a study case. From 2008 to 2011 he worked at the University of Maryland on a project concerning the evolution of the concept of the gene from classical genetics to molecular biology to present-day genomics.

Molecular Mechanisms in the Context of Systems Biology

The main objective of my research program is to elucidate the complex epistemic relationships between

mechanistic explanations in molecular biology and associated wet-lab experimental practices, and newly developed systems biology models and associated bioinformatics approaches. More specifically, I aim to gain a better understanding of how complex systems of molecular mechanisms can be modeled in a computationally efficient way in order to make possible novel predictions about the overall behavior of cells and organisms over extended periods of time, as well as predictions about disease progression and other dynamic aspects of biological phenomena; and how mathematical models of disease and other biological phenomena can provide new insights into the causal processes responsible for producing these diseases and phenomena. In addition to providing better predictions about disease progression and unwanted side-effects of treatments, the integration of mathematical modeling in molecular biology may also reveal thus far unsuspected causal factors, the investigation of which will eventually lead to the development of new treatments, new experimental techniques, and practical applications. I am particularly interested in elucidating the connection between novel, quantitative models of genomic contributions to phenotypes, such as gene regulatory networks (GRNs), and abstract/schematic representations of mechanisms of genome expression. Using gene molecular networks as study cases, I aim to investigate how knowledge of molecular mechanisms contributes to the models devised by systems biologists, and vice versa: what kind of knowledge about molecular mechanisms can be extracted from quantitative models derived from the analysis of large bodies of genomic, transcriptomic, and proteomic data? Several GRNs have been elucidated in great detail, and, at least in some cases, substantial knowledge is available about the biochemical details of the molecular mechanisms underlying them. At the same time, several GRN modeling strategies as well as quantitative models of actual GRNs are available in the scientific literature. Thus, GRNs constitute a suitable study case for investigating the relationship between molecular mechanisms and more mathematical models associated with systems biology.

Ann-Sophie BARWICH
(October 2013 – June 2015)

Ann-Sophie Barwich obtained her MA at the Humboldt-Universität zu Berlin in philosophy and German literature studies. She has finished her PhD in philosophy at the ESRC Centre for Genomics in Society (University of Exeter). Her work addresses classifications and model thinking in olfaction theory and concerns pluralist arguments for scientific realism.

Biology Scenes of Scientific Discovery: Modeling the Olfactory Mechanism at the Intersection of Experimental, Technological, and Conceptually Driven Analysis

The project aims to breathe new life into questions about the nature of scientific discoveries by analyzing their epistemic, empirical, and methodological basis within a contemporary controversy in the life sciences. By questioning whether there are different kinds of discovery within recent developments in olfaction theory, this project analyzes different forms of empirical success in the application of theoretical frameworks. This inquiry is supposed to explore the diverging emphasis in scientific judgments of evidential support within the debate about two competing models that address the molecular basis of odor perception.

Until recently, biologists were in fact unable to identify the specific processes of odor recognition, because the odorant receptors in our nose were so far unknown. In 1991 Linda Buck and Richard Axel eventually discovered a multigene family encoding odorant receptors in the mammalian genome, identifying them as G-protein-coupled receptors. This discovery had important implications for further olfactory research, because it identified smell receptors as a class of G-proteins, which strongly suggests that molecules (causing a particular odor) dock on a specific primary receptor according to a "lock and key" mechanism by virtue of their

shape. Orthodox opinion about primary smell recognition therefore takes shape to be the key feature underlying molecular recognition. However, this account faces several severe experimental problems and still lacks sufficient demonstration. An alternative account, questioning shape and referring to the molecular vibration in the infrared range as the key feature of olfactory molecular recognition, has nevertheless been widely disregarded - yet not sufficiently challenged on its experimental basis.

By contrasting the two accounts this project reconstructs the different strategies of modeling facts, and conducting and interpreting experiments implicit in the competing theories. This comparison will then be used to explore the extent to which scientific discoveries are bound to existing epistemic assumptions in order to be accepted as "evidential."

Olivier MORIN
(November 2013 – June 2015)

Olivier Morin was a post-doctoral fellow at the Department of Cognitive Sciences, Central European University, Budapest. He studied philosophy and cognitive science at the Institut Jean Nicod in Paris with Dan Sperber. His work focuses on theoretical issues in cognitive anthropology. The method he promotes consists in using natural experiments as documented by folklorists or historians to explore the causes of cultural change. He has applied this tool to children`s peer cultures and to visual history. He is also a participant in debates surrounding the philosophy of social science. His dissertation, Cultural Transmission: How Traditions Live and Die, *has been published in French (2011); an English translation has been accepted by Oxford University Press (forthcoming). He is the blog-master of the International Cognition and Culture Institute.*

Biological Generations in Cultural Evolution

Does the succession of biological generations structure cultural change — and if so, how? This research project will investigate the consequences of demographic turnover on the diffusion and mutations of traditions. Two reasons invite us to expect cultural change to be driven by demography. The first reason is the existence of sensitive periods for cultural acquisition: critical "windows" where grammatical parameters (for speakers of a given language), artistic styles (for painters), or theoretical options (for scientists) tend to get fixed more or less irreversibly. The second reason is the slow pace of some changes: they appear to be constrained by the supply of young learners (which in most populations is a more or less constant quantity) rather than determined by the number of models (which can grow exponentially). In spite of this, finding generational dynamics in cultural evolution is not easy. Identifying sensitive periods is a matter of some controversy. The cultural inputs that people are exposed to are changing with time, making the respective contributions of sensitive periods, cognitive maturation, and changing environments difficult to tease apart. The pace and rhythm of cultural change may also differ depending on the subpopulation that one is observing: the adoption of evolutionary theory does not look the same if one looks at it among members of the Royal Society, French zoologists, or American clergymen. These difficulties partly explain why we still lack precise concepts and instruments to estimate, let alone predict, how important generational change will be for a given cultural change.
This investigation will use a simple statistical tool to tackle the issue. The method uses the fact that any individual's birthdate is equal to the date at which s/he is observed, minus her or his age. For any cultural change (given two of these parameters for every data point), this method allows us to know whether the change is driven by generational turnover, by an event that is external to the population, or by a series of individual maturations. Several data sets will be explored using this method, with the aim of developing a general framework for cultural demography. This framework should predict the

importance of generational turnover for various cultural changes, based on their time scale and on the cognitive mechanisms they recruit.

Laura NUÑO DE LA ROSA GARCÍA
(April 2012 – September 2014)

Laura Nuño de la Rosa García graduated in Humanities from the University of Alicante, and joined the doctoral program in Philosophy of Science at Complutense University, Madrid, where she defended her DEA thesis, Philosophical History of the Idea of Organismal Form: From Aristotelian Hylemorphism to Cellular Microanatomy*, in 2005. She subsequently studied biophysics at the Autonomous University of Madrid, and obtained a Master´s degree in biophysics in 2010. She finished her PhD thesis in Philosophy of Biology at the Complutense University of Madrid and the IHPST (Paris) in 2012. Her thesis dealt with the concept of form in contemporary biology, especially in EvoDevo.*

The Problem of Organismal Form: From Description to Explanation. The Case of Vertebrate Limbs

The problem of organismal form played a privileged role throughout the history of biology. However, since the end of the 19th century, the significance of morphology progressively weakened until its near disappearance in the context of the triumph of the Modern Evolutionary Synthesis and the genetic theory of development. Yet, since the late 1970s, morphology has experienced a renaissance in almost every domain of biology, which has brought the spatial dimension of biological entities back to the fore. The return of form in the biosciences has awakened interest in the history of morphology, and drawn increasing philosophical attention to the Aristotelian notion of "formal causation" as well as to morphological concepts such as "type," "homology," and "novelty."

Nonetheless, many historical and philosophical challenges related to the morphological approach to development and evolution remain to be explored. My post-doc project aims at addressing some of these challenges: (1) to explore the historical roots and to analyze the epistemological and ontological implications of the taxonomical and the morphological approach to the problem of form; (2) to examine the interweaving of modeling practices and explanations in developmental biology and EvoDevo; (3) to distinguish the conceptions of causality underlying different explanatory strategies of form in developmental biology and EvoDevo; (4) and to investigate the relationship between form and organization in developmental and evolutionary biology. In line with my philosophical project, I aim at (5) developing an epigenetic hypothesis on one of the most classic and still unsolved problems in the history of evolutionary theory: the origin of vertebrate limbs. According to my hypothesis, the number and position of the paired appendages along the A-P and D-V axes of vertebrates are due to a commonality of tissue environments determined by the global interactions that relate the two types (somatic and visceral) of lateral plate mesoderm.

2.4 Senior Fellowship

Lee ALTENBERG
(April 2014 – March 2016)

Lee Altenberg is an evolutionary theoretician. He served most recently as Associate Professor in Information and Computer Sciences at the University of Hawaii at Manoa. He received his A.B. in genetics with Prof. Glenys Thomson at the University of California, Berkeley, and his Ph.D. in biological sciences with Prof. Marcus W. Feldman at Stanford University. His postdoctoral fellowships include Stanford University, North Carolina State

University, and Duke University, and he served on the faculty of Duke University prior to the University of Hawaii at Manoa. Recently he was a long term visitor at the Mathematical Biosciences Institute at the Ohio State University, and a participant in the program on computational theories of evolution at the Simons Institute at UC Berkeley. He is an Associate Editor of the journal BioSystems, an Editorial Board member of the journal Genetic Programming *and* Evolvable Machines*, and is a founding member of the Board of Directors of the International Society for Artificial Life. He is a member of the Scientific Advisory Board of the EU-funded project, Speed of Adaptation in Population Genetics and Evolutionary Computation (SAGE). He served on the Board of the Maui Classical Music Festival, and was the Chair of the Native Hawaiian Plant Society on Maui.*

Evolution of Development by Natural Selection

My principal project at KLI would be to establish a more comprehensive mathematical framework than currently exists for understanding the evolution of evolvability and robustness --- a subject that despite its rapidly growing body of work remains piecemeal, and where a comprehensive treatment could, I believe, put the existing results in perspective and reveal new directions of inquiry. In particular I wish to focus on the relationship between equilibrium and far-from-equilibrium dynamics and the variational properties that come along with these dynamics. My recent work has focused on the evolution of probabilities of transformation in near-equilibrium populations; the "reduction principle" manifest in this domain appears to also operate on magnitudes and directions of transformation in the form of canalization. The underlying mathematical unity found for transformation probabilities prompts one to ask whether this unity also extends to trans-formation magnitudes and directions. The most challenging area mathematically is far-from-equilibrium, but this is where the evolution of evolvability is mainly generated. Developing new theory for far-from-equilibrium dynamics will be a focus

of this project. Specific topics include:

- The Theory of "Growth and Mixing;"
- The Evolution of Evolvability under Recurrent Environmental Variation;
- Thresholds between Evolvability and Robustness;
- Determinants for the Evolution of Mutational Robustness;
- A Complex Systems-based Quantitative Genetics.

2.5 Visiting Scientists

Fred KEIJZER
(April 2014 – July 2014)

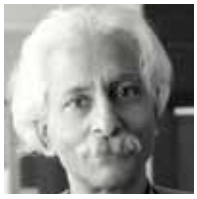
Fred Keijzer holds a Master´s degree in psychology from Utrecht University and a PhD in social sciences from Leiden University. He currently is Associate Professor at the University of Groningen and the Director of the Graduate School in Philosophy.

Nervous Systems and Embodiment

How do nervous systems line up with embodiment? While "embodiment" has become a key notion for cognitive science thanks to Embodied Cognition (EC), the notion remains to a large extent unspecified and can as easily refer to robots as to animals or other organisms. In the present research, I will investigate whether and how the animal sensorimotor organization can provide handholds for making the notion of embodiment more specific for the most salient and complex examples of cognitive systems in existence today: animals, including humans. The approach chosen is to focus on the earliest coevolution of (proto) nervous systems and what became the animal sensorimotor organization. The relevant evolutionary events must have taken place before the Cambrian as modern animal forms already were established at

the beginning of this period. The present research aims to formulate a plausible set of organizational steps that specify how the modern animals sensorimotor system may have evolved from basic precursor systems such as contractile epithelia. Current results from this research strongly suggest that the animal sensorimotor system does have specific features not present in other cases of "sensorimotor systems" such as those of robots and, presumably, organisms other than animals. There are two important implications of this work: (a) The animal sensorimotor organization should be differentiated from superficially similar forms of such an organization. (b) Nervous systems are not control structures that are comparable to artificial control structures, but they are intrinsically tied to the animal sensorimotor organization and constitutive for embodiment.

Vidyanand NANJUNDIAH
(August 2014 – October 2014)



Vidyanand Nanjundiah grew up in Bombay and studied physics and mathematics as an undergraduate. He did a PhD in physics at the University of Chicago and was influenced at Chicago to move into biology. He learnt developmental biology as a post-doctoral fellow, initially at Utrecht (on the axolotl) and then in Tuebingen and Basel (on the cellular slime moulds). Vidyanand Nanjundiah returned to India to join the Indian Institute of Science in Bangalore and taught developmental biology and evolutionary biology. He studied intercellular interactions and cooperative behavior in the cellular slime moulds, at first from a developmental point of view and later as a problem in the evolution of cooperation. He is interested in theoretical biology and expects to concentrate on it in his present home, the Centre for Human Genetics, also in Bangalore.

Information and the Autonomy of Biology and Trade-offs and the Stability of Cooperative Groups

(i) "Information and the autonomy of biology." Does the physical nature of a communication system used within or between living organisms bear on the significance (semantic content) of what is to be communicated? Conversely, does the level of significance constrain the type of signal that can be used? I hope to explore the idea that the extent to which the means of signalling is unconstrained is a reflection of the extent to which (within the context) we can think of biology as being autonomous of physics and chemistry. (ii) "Trade-offs and the stability of cooperative groups." The aim is to explore a model for the evolution of cooperation. Asexual organisms reproduce as individuals and, in between, associate to form groups. A group contains a subset of the genotypes represented in the population. Fitness differences reflect the variation in different traits expressed throughout the life cycle. Can a balance be attained between the various components of fitness and permit the long-term maintenance of genotypic and phenotypic heterogeneity?

Veena RAO
(August 2014 – October 2014)

Veena Rao grew up in Bangalore, India. She has studied medicine, specialised in obstetrics and gynaecology. She taught at St. John's Medical College, Bangalore, and worked in the Institute for Research in Reproduction, Bombay. She contributed over 8 years to the Life Sciences section of the journal "Down to Earth", a journal dealing with health and environmental issues. Veena Rao is currently working on a project supported by the Indian National Science Academy entitled "J.B.S. Haldane's Indian Period". Associated with the National Institute of Advanced Studies, Bangalore, initially as Honorary Research Associate and now as Honorary Adjunct Faculty.

J.B.S. Haldane's "Indian Period"

J. B. S. Haldane, one of the great names in post-Darwinian evolutionary biology, spent the last seven years of his life in India. He continued to work actively until the end. My project deals with aspects of J. B. S. Haldane's "Indian Period" as revealed in his extensive writings and, more broadly, deals with the history of evolutionary thinking. During the time he spent in India, Haldane modified, and to an extent revised, his views on organic evolution. Besides that, he originated entirely new ideas. Some of them have been fruitful, others controversial, and a few have been barely followed up. Among the themes explored in Haldane's "Indian" writings that I propose to work on at the KLI are niche construction, macroevolution, popular reactions to Darwinian ideas and philosophical underpinnings of evolutionary thought.

2.6 Junior Visiting Scientists

Brian McLOONE
(February 2014 – July 2014)

Brian McLoone is a graduate student in the Philosophy Department at the University of Wisconsin-Madison. His research is in biology and cognitive science, primarily the conceptual and methodological issues that arise in both of these fields. At the KLI, Brian will work on a project called "Conceptual Issues Concerning the Ontogeny and Evolution of Human Collaboration." The research he will conduct at the KLI is part of a long-term project to better understand humans' ability to engage in collaborative activities.

Conceptual Issues Concerning the Ontogeny and Evolution of Human Collaboration

A large portion of human social life is founded upon our ability to collaborate with others. We serve on panels with others; we build houses together; we play team sports. Often, such behaviors are described as instances of shared intentionality (e.g., Searle 1995). Here, I will refer to this sort of activity simply as collaboration.

The aim of my project is to write and publish two papers on human collaboration. The first paper will apply philosophical work on the concept of innateness to the issue of whether a child's capacity to collaborate is innate. A number of philosophers of biology and cognitive science have attempted to explicate what innateness means, and in the process they have moved past a naive distinction between innate and acquired characteristics. Indeed, they have shown there are numerous concepts of innateness (e.g., Samuels 2004; Ariew 2006; Griffiths and Machery 2008). Nevertheless, these important theoretical developments have yet to be applied to an analysis of whether human collaboration is innate. I plan to articulate the different senses of innateness and then discuss whether work in developmental psychology supports the claim that any of those senses of the concept describes the ontogeny of human collaboration.

The second paper will explore whether it is appropriate to describe a pair of stag hunters as undergoing a process of group selection. The stag hunt game has been used to describe the payoff-structure of collaboration (Skyrms 2004). Joint cooperation in a stag hunt yields the highest payoff for both the individual and the group. So it is initially plausible that a stag hunting strategy will evolve in a population because of both individual-level and group-level selection (Huttegger and Smead 2011). But coming to a conclusion on this issue involves working through a number of thorny conceptual issues, including concerns about parsimony, explanatory adequacy, and modeling trade-offs.

Federica TURRIZIANI COLONNA
(May 2014 – June 2014)

Federica Turriziani Colonna obtained her Undergraduate Degree in philosophy from Sapienza University of Rome. She eventually moved to France, where she obtained a Master's degree in science sommunication from Ecole Normale Supérieure de Cachan. She then obtained another Master's degree in Philosophy of Science from the Sapienza University of Rome. She currently is a PhD student in History and Philosophy of Science at Arizona State University, where she works as an editor for the Embryo Project Encyclopedia.
She came to the Konrad Lorenz Institute as a Junior Visiting Fellow, to accomplish her archival research.
Since the time when she was undergraduate student, she has been working as a free-lance translator for different publishing companies. She translated philosophy books and biology books, including S.J. Gould's Ontogeny and Phylogeny.

History of Experiments Performed at the Intersection Between Evolution, Development, and Environment in the Early 20th Century in Vienna

My research focuses on the history (1890s-1940s) of the institutional relationships between southern European marine laboratories, including the Zoological Station in Trieste, Italy, the Vivarium in Vienna, Austria, and the Zoological Station in Naples, Italy.

I aim to understand (1) how the Trieste institution influenced the establishment of the Vivarium and, conversely, how the Vivarium influenced the Trieste institution research projects; (2) what was the network of scholars working between the Trieste institution and the Vivarium in the first four decades of the 20th century and what their research projects were; (3) what experiments were the Vienna-based researchers conducting at the Zoological Station in Naples in the 1890s-1940s.

I expect to find that the research projects in these southern European institutions included experiments on the raise of variation as a causal explanation for evolutionary and developmental phenomena.

2.7 Scientists with Own Funding

Teresa BLASCO MÁÑEZ
(September 2013 – June 2014)

Teresa Blasco Máñez is a doctoral student at the Universidad de Oviedo. She was a visiting student at the "Centre de Lingüística Teòrica" (Universitat Autònoma de Barcelona). Her project advisors are Guillermo J. Lorenzo González (Universidad de Oviedo) and Sergio Balari Ravera (Universitat Autònoma de Barcelona).

Biological Foundations of Music and Language: A Comparative Structural Approach

The evolutionary study of language and music has traditionally been addressed within the context of a selectionist framework in which the emphasis placed on the functional uniqueness of mechanisms too often obscures parallels at the level of organic structure on which evolutionary accounts should be grounded. The main objective of my PhD project is to approach a comparison of the evolutionary biology of music and language as cognitive capacities following a structural (non-functionalist), internalist perspective, where data from different levels of organization (developmental, anatomical, genetic) become integrated in order to establish homologies and degrees of continuity. One of the central concerns of my work is thus to place the discussion about these capacities within a realistic,

theoretically-informed and biology-grounded framework, by incorporating from biology the basic principles of modern evolutionary theory. In this sense, my project owes much to works previously carried out within the context of the research group leaded by Guillermo Lorenzo and Sergio Balari who were in turn influenced by the work of EvoDevo biologists such as Pere Alberch.

Mathieu CHARBONNEAU
(March 2013 – February 2015)

Mathieu Charbonneau completed his PhD in philosophy of science and of biology at the Université de Montréal. His dissertation examined how the use of explanatory analogies between evolutionary biology and the social sciences informs the construction of a theory of cultural inheritance and structures its explanatory framework.

Cultural Development and Cultural Evolution

In the last forty years, Darwinian theories of cultural evolution have mainly focused on the transmission patterns of cultural variants, either at a micro-evolutionary scale (dual inheritance theory) or at a macro-evolutionary scale (cultural phylogenetics). This emphasis on transmission comes from an affinity with the modeling strategies used in population genetics and phylogenetics. From this, a research program analogous with evolutionary biology has been suggested to synthesize the social sciences into an evolutionary framework. However, clearly absent from this scheme is a study of cultural development serving as an analogous cultural science of EvoDevo. Nevertheless, implicit in these theories lies an underexplored developmental component. On the one hand, the modeling strategies borrowed from population genetics are based on the life cycle of human organisms, thus construing cultural development as the development and

sequential enculturation of the socializing organism. On the other hand, the analogy between the ideational notion of culture and genotype/phenotype relationship suggests that cultural development should be understood as the processes by which cultural products (behaviors, artifacts, and institutions) are produced by the cultural information transmitted from one individual to another. According to this reading, investigating cultural development would consist not so much in examining how social organisms develop but rather in explaining the neurocognitive processes, sensorimotor feedback loops, and behavioral sequences by which artifacts and institutions are produced and maintained. My postdoctoral project aims at elucidating how cultural development may be integrated in cultural evolution studies and to examine whether a cultural analog to EvoDevo makes sense and, if so, what kind of explanatory benefit it would offer. I'm also interested in clarifying the theoretical relationships between both perspective of cultural development (development of the socializing organism, development of the cultural object), the manner by which they can be integrated into a Darwinian framework of cultural evolution, and to determine if both interpretations can be complementary to one another, and if so, how.

Marko JURJAKO
(October 2014 – November 2014)

Marko Jurjako is a PhD candidate in philosophy at the Faculty of Humanities and Social Sciences in Rijeka (Croatia). He graduated in philosophy and history at the Faculty of Humanities and Social Sciences in Rijeka and philosophy and cognitive science at the Central European University in Budapest (Hungary). Jurjako was a visiting fellow at the KLI and is currently a fellow at the Faculty of Humanities and Social Sciences (University of Rijeka).

Evolutionary Origins of Moral Reasons: Conceptual and Ontological issues

The general question that I am addressing in my overall research is whether the concept of a moral reason can be accounted for in naturalistically respectable terms. The basic idea that I am developing in my research is the one proposed by Smith (2012) and Williams (1981). Namely, the idea is that the first step in accounting naturalistically for the concept of a reason is to connect it to a concept of rational belief and desire. Rationality of a belief and a desire is naturally construed as providing standards of correctness for beliefs and desires; in other words specifying the rationality of beliefs and desires consists in specifying their proper functions (see Milikan, 1984). Introducing the concept of a function enables one to interface normative concepts with scientifically respectable concepts.

The second step is to investigate the function of moral beliefs. This can be done in at least two ways; one is to investigate into proximal (cognitive) mechanisms that underpin moral judgments, and the second is to investigate distal mechanisms, that is the evolutionary origins of current moral practices. The latter is the project I conducted while I was a visting fellow at the KLI Institute. In particular, the project investigated what function can be ascribed to moral beliefs and why in particular we intuitively objectify the contents of moral beliefs (the moral reasons) in a way that does not seem to be compatible with the general scientific picture of the world.

My research plan had three phases:

1. Phase investigates the question whether there is a feasible explanation of the concept of a function that relies on evolutionary considerations. Moreover, the question is: if the concept of a function cannot be given an evolutionary explanation, does that diminish its scientific respectability? (see Cummins, 2002).

2. Phase consists in investigating the evolutionary origins of moral behaviour and its cognitive and emotional underpinning. In particular, the research concern the function

of morality and its presupposed benefits in maintaining the cooperation in a certain society.

3. The final phase connects the first two by investigating the relation between the fitness and utility. The idea is that moral reasons are codified in agent's utility function (or preferences represented by the utility function) and that evolution of moral behaviour has to do with fitness-enhancement. However, at least at the surface level it seems that individual's utilities (moral reasons) do not necessarily follow fitness considerations. I analyse the apparent discrepancy in order to elucidate its significance for the connection between moral reasons and its evolutionary origins (see Sterelny, 2012).

Eveline SEGHERS
(September 2014 – October 2014)

Eveline Seghers is a fellow of the Research Foundation Flanders (FWO) and a graduate student in the Department of Art, Music and Theatre Studies at Ghent University (Belgium). She holds degrees in art history, world art studies, and cultural anthropology (BA & MA, Ghent University), and in biological anthropology (MSc, University College London). Her ongoing PhD work discusses methodological and conceptual issues and questions in the evolutionary study of visual art. She has written on the relationship between evolutionary and philosophical aesthetics, the current state of evolutionary psychological research on art, and the use of cross-species comparison. Her current research focuses on the cognitive foundations of various kinds of prehistoric art, and on non-adaptationist approaches to the origins of art.

Adaptationist and Co-evolutionary Reasoning on Art: A Methodological Inquiry into the Theoretical Foundations of Evolutionary Hypotheses on Art

The evolutionary study of art is an upcoming area of research that has drawn the attention of scholars in humanities disciplines such as art history and archaeology, as well as in fields that are already accustomed with evolutionary and cognitive thought, such as psychology and anthropology. The amount research done on art is still rather limited, and insufficient attention has been paid to its methodological foundations. As a consequence, a large number of theoretical, conceptual, and methodological issues remain to be clarified and elaborated upon in order to advance an evolutionary understanding of art. This project focuses on the legitimization of adaptionist claims, through an assessment of the current set of arguments provided in favor of such theories. Existing hypotheses tend to focus on attributing different functions to art, while little thought has been given to whether artistic behavior, through any of the proposed functions, should increase differential reproductive success. While several authors have tried to accommodate this gap, many questions still remain to be solved, and new promising approaches are awaiting further development. In addition, this proposal explores the as yet underestimated possibilities of gene-culture co-evolution and cultural evolution frameworks. The latter are continuously applied for studying a variety of human behaviors, but are generally neglected when it comes to art. Examining these frameworks will not only deepen our current understanding of art from an evolutionary and cognitive perspective; it can also shed light on some of the outstanding issues in the adaptionist debate on art. In sum, this project aims to gather various scattered hypotheses and ideas while also addressing a number of methodological issues, with the aim of achieving an integrated and theoretically sound evolutionary framework of the arts.

Meetings and Lectures

3

The KLI supports international workshops, symposia, and individual talks that are organized either by the KLI or in cooperation with other institutions.

3.1 Altenberg Workshops in Theoretical Biology

The "Altenberg Workshops" address key questions of biological theories. Each workshop is organized by leading experts of a certain field who invite a group of international specialists to the KLI. The Altenberg Workshops aim to make conceptual progress and to generate initiatives of a distinctly interdisciplinary nature. Further information concerning the participants and their presentations can be found on the KLI website. Workshops hosted at the new institute building in Klosterneuburg are continued as "Altenberg Workshops."

30th Altenberg Workshop in Theoretical Biology 11 – 14 June 2014

Quality & Quantity: Limits of Quantification in the Sciences
The KLI Institute, Klosterneuburg

Organization: Richard Nelson, Werner Callebaut, and Isabella Sarto-Jackson

Topic and Aims

The workshop will focus on the oppositions between "quantitative" and "qualitative" research that abound in the scientific and philosophical literature, but are often deeply misleading. By way of example, does it make sense to call the way organic molecules are characterized "qualitative" because much more than "numbers" is involved? On the other hand, can we claim that their characterization is "quantitative" only? Scientific fields (and subfields within them) in the natural and social sciences differ substantially in the ways in which they rely on quantification, and to what extent. For instance, it is often suggested that in (parts of) physics, mathematics plays a "constitutive" role with respect to concepts and theories, and that this distinguishes physics from other sciences. Our main aim is to articulate a comparative framework that usefully accounts for the ontological, epistemological, and methodological aspects of "quality and quantity" talk, and enables a constructive debate on these and related issues.

Three rather different issues are often conflated in the arguments about quantity and quality: characterization of the phenomena; theory (articulation of causal relationships); and research methodology. Lord KELVIN was referring to the first issue when he said: "When you can measure what you are speaking about,

and express it in numbers, you know something about it: but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."

The use of quantities (counts or measures) to characterize/describe the subject matter a scientific field deals with—its "phenomenology"—should be distinguished clearly from the use of mathematics in its theorizing. Both often go together, but not necessarily so: In many sciences the subject matter is largely described quantitatively, but the theory is not mathematical. In other sciences mathematical models are used to suggest what is going on in a subject whose description is largely qualitative.

The use (or not) of quantitative research methods further complicates the picture. Many quantitative methods in the natural sciences rely on instruments that cannot capture exhaustively the features of the objects under study. In many fields researchers use measures they construct or select that they know are partial and inexact characterizations of the phenomena in which they really are interested in, in order to do statistical analysis.

The perceived divide between "quality" and "quantity" has roots in diverse intellectual heritages, including the Aristotelian tradition. One way of thinking that gained prominence after the Scientific Revolution is epitomized in GALILEO's dictum that "the book of nature is written in the language of mathematics." In this view, mathematical theorizing can provide the basis of a unified theory of nature formalized in a universal calculus whose axioms and rules can be applied independently of the object under study; but see ISRAEL (1996) on how the advent of modeling (LOTKA, VOLTERRA...) led to the evaporation of this dream.

Other scientists and scholars, rather following Francis BACON 's lead, have red-flagged the quantitative worldview, worrying that logic and mathematics might impose laws of their own to the detriment of the integrity of the object of research. Exclusively quantitative approaches, they fear, might unduly constrain or distort theory development, which requires a rich and deep understanding of phenomena, to be gained only through—iterative—quantitative and qualitative inquiries. Quantitative research captures phenomena in mathematical terms that suggest objectivity ("the language of God"). But it is a non sequitur that quantification is able to avoid subjectivity on, say, individual, interpersonal, or political levels. In practice, scientists usually aim for consensus or inter-subjective agreement as imperfect proxies for objectivity. This is recognized in calls for "gold standards" or double blind, randomized approaches, indicating that subjectivity and objectivity are not opposites but, rather, mutually dependent in a dialectic manner. Moreover, quantitative research might imply a narrowing down and impoverishment of the research goal, and lead to missing out grossly on the

"complete" description of phenomena (which is elusive anyway). In contrast, non-mathematical representations such as narratives (which may include analogy and metaphor) or non-numeric symbols (figures, graphics, etc.) that afford multi-dimensional descriptions constrict research less by enabling access to objects or processes from different methodological or cognitive angles. [Natural] phenomena are complex, our scientific interests in them are heterogeneous, and the number of possible ways of representing them...is large. (GRIESEMER 2000)

Finally, quantitative research is often suggested to be superior to its qualitative counter-part, supposedly justifying the ambition to "measure what is measurable, and make measurable what is not so" (GALILEO) in terms of precision and rigor. But what does this mean in practical terms? IQ is a good example of a measure of something that may not be measurable (at least not simply). Or consider the periodic table of elements: should we characterize is as "mathematical," "quantitative," "qualitative," or as something distinct still?

Program

LILIANA ALBERTAZZI
University of Trento
Qualitative Appearances

ANN-SOPHIE BARWICH
The KLI Institute
"The Standard Observer": Humans as Measurement Instruments for the Quantification of Odor Qualities

FRED BOOKSTEIN
University of Washington & University of Vienna
No Quantification Without Qualification, and vice versa: A Multilayered Pattern Language for Tomorrow's Observational Biosciences

WERNER CALLEBAUT
The KLI Institute
A Short History of Quality

VERENA HALSMAYER
University of Vienna
Making Economic Growth a Measurable Entity

EVELYN FOX KELLER
Massachusetts Institute of Technology
Assessing Risk in the Absence of Quantifiability

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The KLI Institute
"One Fact, one Vote!": Quantitative Methods and the Democracy of Evidence

KATHERINE NELSON
City University of New York
The Quantitative Emphasis in Psychology

RICHARD NELSON
Columbia University, NY
Description, Narratives, and Numbers, and Models in Analysis of Long Run Economic Development

ROBERT J. RICHARDS
University of Chicago
Between Quality and Quantity: The Archetype from Kant and Carus to D'Arcy Thompson and EvoDevo

ISABELLA SARTO-JACKSON
The KLI Institute
Transgressing the Borders of Quantification by Data Visualization

JORGE WAGENSBERG-LUBINSKI
University of Barcelona
Is Quality Quantitatively Measurable?

ULRICH WITT
Max Planck Institute of Economics, Jena
Kinds of Causal Explanations and Their Affinity to Quantification: The Case of Economics

31st Altenberg Workshop in Theoretical Biology 25 – 28 September 2014

The Origins and Consequences of Multicellularity
The KLI Institute, Klosterneuburg

Organization: Karl Niklas and Stuart Newman

Topic and Aims

Multicellularity has evolved independently in ten different lineages, each of which had a unicellular ancestral condition. Its evolution involved the appearance of physiological mechanisms resulting in cell-to-cell adhesion and sustained inter-cellular communication among adjoining cells. A comparative approach among extant lineages shows that these two requirements have been achieved in different ways among different plant, animal, and fungal groups; e.g., cell-to-cell adhesion and communication in metazoans typically involve membrane-bound glycoproteins and tight junctions, whereas land plant cell adhesion and communication result from a pectinaceous middle lamella and plasmodesmata. Critical questions in this context are: What are the genomic and developmental commonalities (and the unique features) among multicellular lineages that permit cell-to-cell adhesion and communication? What are the selective advantages (and disadvantages) to the evolution of these defining features of multicellular organisms? What physical consequences follow from the multicellular state of life, and can these provide insight into the origins of morphological novelties? In addition, the evolutionary transition from the unicellular to the multicellular condition is a major change in individuality since a new kind of organism emerges from the interactions and cooperation among subunits (cells). Until recently, discussions about this transition have been characterized by two divergent schools of thought, one focusing on the so-called 'unicellular bottleneck' between alternating generations, and another school focusing on 'soma-germ' specialization. More recently, the focus has become more synthetic by considering the 'unicellular bottleneck' in terms of the 'alignment-of-fitness' phase (wherein genetic similarity among cells prevents internal conflict) and 'soma-germ' specialization in terms of an 'export-of-fitness' wherein cellular components become interdependent and collaborate in reproductive effort. This perspective raises a number of important questions. For example, does the unicellular bottle-

neck in the life cycles of multicellular organisms assure an alignment-of-fitness? Does multicellular "individuality" evolve as the result of a gain in fitness achieved by cellular specialization?

Finally, recent knowledge of the physical underpinnings of morphogenesis and pattern formation in multicellular organisms raise questions that go beyond the adaptationist framework of traditional evolutionary theory. In particular, to what extent are morphological motifs inevitabilities of a new scale of cellular life that afford opportunities to explore and create entirely novel niches? Is the evolution of multicellularity typically a "left wall"—that is, is it a generally irreversible event in the history of many, if not the majority of lineages, and if so, why?

Program

MAJA ADAMSKA
University of Bergen
Sponges as the Rosetta Stone of Colonial-to-Multicellular Transition

ARGYRIS ARNELLOS
The KLI Institute
Integration of Constitutive and Interactive Aspects in the Transition from Unicellular to Multicellular Organisms

MARIANA BENÍTEZ KEINRAD
Universidad Nacional Autónoma de México
Physicochemical Factors in the Organization of Multicellular Aggregates and Plants

DAVID R. CRAWFORD
University of Bristol
Evolution of Multicellularity in the Fungi: Alternative Routes

LIAM DOLAN
University of Oxford
Principles of Cell Development in the Evolution of Multicellularity

KUNIHIKO KANEKO
University of Tokyo
Multi-level Consistency Dynamics for Multi-cellular Organisms

ANDREW H. KNOLL
Harvard University
Protistan Feeding and the Origins of Complex Multicellularity

MANFRED LAUBICHLER
Arizona State University
An Extended Evolution Perspective on the Origin and Consequences of Multicellularity

OTTOLINE LEYSER
University of Cambridge
Auxin, Self-Organisation and the Colonial Nature of Plants

ALAN LOVE
University of Minnesota
Explaining the Origins of Multicellularity: Criteria of Adequacy and Epistemological Prerequisites

VIDYANAND NANJUNDIAH
Centre for Human Genetics, Bangalore
Cellular Slime Moulds and the Transition from Solitary to Social Living

STUART NEWMAN
New York Medical College
The Role of the Egg in the Evolutionary Consolidation of Animal Body Plans

KARL J. NIKLAS
Cornell University, NY
Convergent Motifs in the Acquisition of Multicellularity

WILLIAM RATCLIFF
Georgia Institute of Technology, Atlanta
What Experimental Evolution in *Saccharomyces* and *Chlamydomonas* Reveal about the Transition to Multicellularity

IÑAKI RUIZ-TRILLO
Universitat de Barcelona
The Origin of Metazoan Multicellularity: A Genomics and Cell Biology Perspective

RICARD SOLÉ
Universitat Pompeu Fabra, Barcelona
Synthetic Transitions to Multicellularity

PAVEL TOMANCAK
Max Planck Institute of Molecular Cell Biology and Genetics, Dresden
Developmental Hourglass and the Chicken and Egg Causality Dilemma

3.2 Summer School

3rd European Advanced Seminar in the Philosophy of the Life Sciences
1 – 5 September 2014

Ontological Issues in the Life Sciences
The KLI Institute, Klosterneuburg

Directors: Giovanni Boniolo and Werner Callebaut

Co-organizing institutions: Egenis, the Centre for the Study of Life Sciences, Exeter; European School of Molecular Medicine (SEMM) & Department of Health Sciences, University of Milan; Institut d'Histoire et de Philosophie des Sciences et des Techniques, Paris-1 Panthéon – Sorbonne; KLI Institute, Klosterneuburg/Vienna; IUFE, Faculty of Science & Department of Philosophy, Faculty of Humanities, University of Geneva; Department of Logic and Philosophy of Science, University of the Basque Country, San Sebastian

Topic and Aims

L'ontologie fait corps avec la science elle-même et ne peut en être séparée.

Emile Meyerson

Dictionaries such as Webster's define ontology as the "branch of metaphysics concerned with the nature and relations of being." Western philosophy began as a quest for "the furniture of the world." Think of EMPEDOCLES' four "roots," which have become better known as the "elements": Fire, Air, Water, and Earth. ARISTOTLE related each of these four elements to two of the four "sensible qualities": hot/cold, wet/dry. If in Greek natural philosophy these entities were thought through the lens of a strong and necessary ontological commitment, the modern sciences that took shape after the Scientific Revolution, including biology, may be seen as transforming the ancient ontological quest in terms of specialization and the use of increasingly sophisticated experimental and other empirical tools (and later also modeling), in addition to the theorizing that was—and remains—so dear to philosophers.

On this "replacement of philosophy by science" picture, it might seem that the age of philosophical ontology has gone for good—a conclusion that the logical empiricists were eager to draw about a century ago. For them, philosophy's only proper concern is the "logical analysis of the body of accepted scientific theories" (CARNAP). Representatives of the Vienna Circle's "scientific world-conception" such as NEURATH no longer wanted to use the term "philosophy" for their work at all, "so as to emphasize the contrast with the philosophy of (metaphysical) systems even more strongly."

However, whereas QUINE's ontological relativism killed whatever remained of the old dream of an aprioristic philosophical ontology that somehow "precedes" scientific investigation, his demolition of the analytic/synthetic distinction, which the positivist edifice required for its foundation, re-opened, maybe somewhat paradoxically, the door for a "scientific" metaphysics. As ALEX ROSENBERG (1985) has argued in a discussion of entelechy,

The justification for eliminating or embracing such notions as DRIESCH's entelechy is no different in kind from that employed to assess claims about the existence of electrons, magnets, or virons. It differs from them by degree, and very great degree at that. But ridding biology of such notions is ... all a matter of applying some rule against useless metaphysics. For deciding on the existence or non-existence of entelechies is nothing less than questioning the legitimacy of competing embryological theories altogether.

The "new" philosophy of biology that took shape in the mid-1970s was informed by the post-positivist developments in philosophy of science (QUINE's influence being mostly indirect, through the major impact of KUHN). Among its subjects, ontological issues are legion; to mention but a few examples:

- If biological species evolve, they cannot be logical classes but must be "individuals" of some sort.
- In a discipline such as systematics, confusion as to the significance of definitions often leads to mistakes. "Definitions apply only to words, not to the things to which they correspond" (GHISELIN).
- The "gene's eye view" vs. multi-level accounts of living systems, "causal democracy" of developmental resources, etc.
- The individuality of organisms—microbiological, immunological, and other issues.
- Ecosystems as organisms, organisms as ecosystems…

Whereas philosophy has traditionally shown but disdain for the "application" of scientific knowledge, many theoretical changes in the life sciences today are initiated by practical and technological applications, and many theoretical advances are pursued to answer to technical problems.

This turn has been particularly evident concerning ontology. Whereas classical philosophical ontology was devoted to speculation on "what there is"—the 'fundamental' entities in the world—nowadays, in particular in what is called applied ontology, it deals increasingly with computerized knowledge representation and data integration. From a computational perspective, an ontology is a way of computationally modeling/ representing a particular area of knowledge, or computationally integrating/representing different areas of knowledge.

The rapidly growing field of applied ontology has recently acquired more and more relevance in the context of the sciences dealing with living beings. Bio-ontologies are proliferating in the management of many databases concerning living beings or parts of them (molecules, cells, tissues, etc.). This success is explained by the changing nature of biological research. While until some decades ago research in the life sciences was mainly observational, major advances in molecular biology and genomic technologies have led to an information overload that cannot be processed and analyzed by biological methods. Nowadays, most biological subfields are computer-aided, resorting to powerful bioinformatics tools that are required to store, organize, and index the continuously increasing mass of data. But coupling these rapidly expanding fields opened the door to the data deluge even wider: the amount of data produced exceeds the possibility of their analysis. Bio-ontologies are a candidate to manage this information explosion by modeling and integration, since they can also bridge different levels of research on living beings connecting data, for example, from molecular biology to clinical medicine, by aligning molecular details to pathology and anatomy.

However, this picture reveals a dangerous epistemological naiveté and basic ignorance of the history of science itself. First, even if many computer scientists conceive of ontology in a simple way (without considering its history), the philosophical tradition provides many different approaches to ontological problems that can inspire new technical applications.

Second, a genuine epistemological analysis can provide theoretical support for another type of integration, knowledge integration, which is not separated from data integration but rather constitutes its counterpart. Epistemological expertise, supported by up-to-date knowledge of the science, plays a crucial role in understanding the practice of actual research. Moreover, a scientific enterprise aware of its historical and epistemological dimensions can take advantage of this level of analysis to refine and shape its methodological approach and the interpretation of those aspects of produced results that are normally neglected by scientists (the issue of theory-ladenness).

Program

FEDERICO BOEM
Milano
Bio-ontologies: Orienteering Tools for Biomedical Research

RUSSEL WINSLOW
Santa Fe
On the Ontology of Biological Space

MARTIN BERZELL
Linköping
Commentary

KEPA RUIZ-MIRAZO
San Sebastian
"Synthetic Protocell Philosophy": Fabricating New Ontological Constructs, *in vitro* and *in silico*, to Establish More Solid Epistemological Bases for Biology

SUNE HOLM
København
Commentary

GERD B. MÜLLER
The KLI Institute
Theories of Development: Programs, DST, EvoDevo

JAMES LOWE
Exeter
Ontological Issues in Developmental Biology: Taking Variation Seriously

GAËLLE PONTAROTTI
Paris
Integrating Expanding Data in Pluralistic Models of Heredity: Toward an Organizational Framework

EWELINA SOKOŁOWSKA
Uppsala
Commentary

MARIA KRONFELDNER
Bielefeld
How Behavioral Scientists Deal with Explanatory Complexity

GUILLAUME SCHLAEPFER
Genève
Commentary

THIBAULT RACOVSKI
Exeter
Evolutionary Novelty, a Concept Still in Search of a Definition

VANESSA TRIVIÑO ALONSO
Murcia
Emergent Properties in an EvoDevo Biological Context

LAURA NUÑO DE LA ROSA GARCÍA
The KLI Institute
Commentary

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Genève
Individuals, Cells, and the Special Composition Question

NICHOLAS BINNEY
Exeter
Commentary

ISABELLA SARTO-JACKSON
The KLI Institute
Ontologies of Protein-Ligand Binding Complexes

ANN-SOPHIE BARWICH
The KLI Institute
Commentary

ERIC ROGERS
Cincinnati
Selection or Sorting: The Conceptual Obscurity of Species Selection

CELSO ANTÔNIO ALVES NETO
Hannover
Commentary

VIDYANAND NANJUNDIAH
The KLI Institute & Bangalore
Arbitrariness in Information Transfer and the Autonomy of Biology

PIERRE-LUC GERMAIN
Milano
Commentary

JAMES DIFRISCO
Leuven
Time Scale and Levels of Organization

MARCO TAMBORINI
Heidelberg
Ontological Issues in Paleobiological Data: What is the Fossil Record?

DANIEL BROOKS
Bielefeld
Commentary

MARCO J. NATHAN
Denver & Milano
On the Role of Counterfactual Reasoning in the Biological Sciences

MAXIMILIAN HUBER
Genève
Commentary

DANIEL J. NICHOLSON
Exeter
Are Biological Mechanisms Real?

JOERI WITTEVEEN
Utrecht
Commentary

ZDENKA BRZOVIC
Rijeka
Multiple Realizability of Functional Kinds

JÖRG RÄWEL
Zürich
De-ontologization of Individuality in Evolutionary Biology

PAOLA HERNÁNDEZ-CHÁVEZ
México D.F.
Commentary

ERIC GARNIER
Montpellier
Using Ontologies for Ecological Research

ANTOINE DUSSAULT
Montréal
Commentary

EVA FERNÁNDEZ-LABANDERA TEJADO
San Sebastian
Regulation and Its Main Features

EMANUELE RATTI
Milano
The Hybridization Between Data-driven and Hypothesis-driven Research: A Proposal Based on the Debate About the Relation Between Discovery and Justification

MARKO JURJAKO
Rijeka
Commentary

MATTEO MOSSIO
Paris
Organization and Biological Individuation

ARGYRIS ARNELLOS
The KLI Institute
Commentary

FRANCESCA MERLIN
Paris
The Limited Extended Nature of Biological Inheritance

MATHIEU CHARBONNEAU
The KLI Institute
Commentary

JOHN DUPRÉ
Exeter
Living Systems: Processes or Things?

ANTONINE NICOGLOU
Paris
Commentary

3.3 Collaborative Events

Symposium
Hundert Jahre Biologische Versuchsanstalt
6 – 7 February 2014

Theatersaal & Clubraum der Österreichischen Akademie der Wissenschaften

Organization: The KLI Institute und Österreichische Akademie der Wissenschaften

Die Biologische Versuchsanstalt (BVA) im Wiener Prater war eine der weltweitersten Forschungseinrichtungen für experimentelle Biologie. 1903 von den Biologen Hans Przibram, Wilhelm Figdor und Leopold von Portheim privat gegründet, wurde die BVA 1914 der Akademie der Wissenschaften als Schenkung übertragen. Nach dem „Anschluss" 1938 wurden ihre Gründer sowie viele Mitarbeiterinnen und Mitarbeiter aus „rassischen Gründen" verfolgt und vertrieben. Einige kamen in nationalsozialistischen Konzentrationslagern zu Tode. In den letzten Kriegstagen wurde das Gebäude weitgehend zerstört, 1946 wurde die BVA aufgelöst.

Ziel der Konferenz ist es, zum hundertsten Jahrestag der Übernahme der Biologischen Versuchsanstalt im Prater durch die Akademie der Wissenschaften den wissenschaftlichen, personellen und institutionellen Aspekten der Geschichte dieser international wegweisenden Forschungseinrichtung nachzugehen.

Program

ANTON ZEILINGER
Österreichische Akademie der Wissenschaften
Begrüßung

SABINE BRAUCKMANN
Tartu Ülikool
JOHANNES FEICHTINGER
Österreichische Akademie der Wissenschaften
Die BVA: Forschung in der Akademie

GERD B. MÜLLER
The KLI Institute & Universität Wien
Die BVA als internationales Forschungszentrum

MANFRED D. LAUBICHLER
Arizona State University
Entwicklung, Evolution und Vererbung

Biologie und Politik um 1900
Moderation: Wolfgang Reiter

MITCHELL G. ASH
Unversität Wien
Wissenschaft und Politik in Österreich: Wechselwirkungen

HEINER FANGERAU
Universität Ulm
Experimentelle Biologie und die Entwicklung des biomedizinischen Programms um 1900

Die BVA in Wien
Moderation: Carola Sachse

GEORG GAUGUSCH
Wien
Topographie einer jüdischen Familie

VERONIKA LIPPHARDT
Max Planck Institut für Wissenschaftsgeschichte, Berlin
“Wissensraum Wien” und Jüdische Identität um 1900

KLAUS TASCHWER
Der Standard, Wien
Der Krötenküsser und die Bärenhöhle

Das Forschungsprogramm der BVA: Zwischen Theorie und Experiment
Moderation: Sabine Brauckmann

GERD B. MÜLLER
The KLI Institute & Universität Wien
Experimental-Zoologie (Zoologische Abteilung)

KÄRIN NICKELSEN
Ludwig-Maximilian Universität München
Die Wiener Schule der Pflanzenphysiologie (Botanische Abteilung)

VERONIKA HOFER
University of South Carolina, Columbia, SC
Kolloid-Chemie an der BVA (Chemische Abteilung)

CHERYL A. LOGAN
University of North Carolina, Greensboro, NC
The Physiology of Erotisierung (Physiologische Abteilung)

BVA goes USA: Die Forschungen von Eduard Uhlenhut, Theodor Koppanyi und Paul Weiss
Moderation: Friedrich Stadler

SABINE BRAUCKMANN
Tartu Ülikool
Theodor Koppanyi und Paul Weiss

KATE E. SOHASKY
Johns Hopkins University, Baltimore, MD
BVA in Transnational Perspective: The Cold Spring Harbor Connection

TANIA MUNZ
Northwestern University, Evanston, IL
Fisch im Prater: Karl von Frischs frühe Arbeiten in der BVA (1909–1910)

JOHANNES FEICHTINGER
Österreichische Akademie der Wissenschaften
Wien 1900: Wissenschaft und Experiment

5th Meeting of the European Society for Evolutionary Developmental Biology (EED) 22 – 25 July 2014

Campus of the University of Vienna

Organization: Euro Evo Devo Society, University of Vienna, and the KLI Institute

This conference brought together scientists and students from all over the world aiming to present and discuss forefront research and future perspectives in EvoDevo.

Program

Keynote Lectures

VERONICA GRIENEISEN
John Innes Centre, Norwich
A "DevoEvo" Approach to Unravel the Hidden Logic of Cell and Tissue Polarity in Plants and Animals

JEAN-JACQUES HUBLIN
Max Planck Institute for Evolutionary Anthropology, Leipzig
Becoming Fully Human

STUART NEWMAN
New York Medical College
Ancient Genes, Mesoscale Physics, and the Origins of Animal Development

ULRICH TECHNAU
University of Vienna
The Evolution of Key Bilaterian Traits: Insights from Regulatory Developmental Networks in *Cnidaria*

Ecological and Environmental Impacts in the Evolution of Organismal Development
Organizers: Chris Lowe, Angelika Stollewerk
Speakers:
EHAB ABOUHEIF, McGill University, Montréal
CHRISTIAN LAFORSCH, University of Bayreuth
MATT ROCKMAN, New York University
BLANCHE CAPEL, Duke University, Durham
BEVERLEY GLOVER, University of Cambridge
RALF SOMMER, Max Planck Institute for Developmental Biology, Tübingen
ILYA RUVINSKY, University of Chicago
MICHAEL TRAVISANO, University of Minnesota

EcoEvoDevo – Symbiosis and Epigenetic Inheritance
Organizers: Scott F. Gilbert, Yoav Soen
Speakers:
SCOTT GILBERT, University of Helsinki
CATHERINE MASSON, INRA, CNRS, Castanet-Tolosan
ODED RECHAVI, Tel Aviv University
YOAV SOEN, Weizmann Institute of Science, Rehovot

Developmental Basis of Quantitative Variation
Organizers: Mihaela Pavlicev, Günter Wagner
Speakers:
JIM CHEVERUD, Loyola University, Chicago
ARNE GJUVSLAND, Centre for Integrative Genetics, Ås
FREDERIC GUILLAUME, University of Zürich
GÜNTER P. WAGNER, Yale University

How Does Developmental Robustness Facilitate the Evolution of Biodiversity?
Organizers: Rainer Melzer, Günter Theißen
Speakers:
MATTEW WILLS, University of Bath
THOMAS HANSEN, University of Oslo
MICHALIS BARKOULAS, Imperial College London
ANGELA HAY, Max Planck Institute, Cologne

54 **Quantitative EvoDevo in Model and Non-model Organisms**
Organizers: Benedikt Hallgrimsson, Chris Klingenberg, Philipp Mitteroecker, Ruth Flatscher
Speakers:
BENEDIKT HALLGRIMSSON, University of Calgary
ANJALI GOSWAMI, University College London
JIRI NEUSTUPA, Charles University Prague
PHILIPP MITTEROECKER & CHRISTINE MAYER, University of Vienna
JUKKA JERNVALL, University of Helsinki
JOSÉ MARÍA GÓMEZ, University of Granada
SCOTT ARMBRUSTER, University of Portsmouth
CHRISTIAN KLINGENBERG, University of Manchester

EvoDevo of Cranial Neural Crest Populations Across Developmental Systems
Organizer: Georgy Koentges
Speakers:
JOHANN EBERHART, University of Austin
JOSHUA GROSS, Harvard University & University of Cincinnati
SOPHIE CREUZET, CNRS, Gif-sur-Yvette
GEORGY KOENTGES, University of Warwick

Less is More: Loss of Gene Functions as a Driving Force of Developmental Evolution
Organizers: Ingo Braasch, Cristian Cañestro
Speakers:
PETER HOLLAND, University of Oxford
JOHN POSTLETHWAIT, University of Oregon
SHIGEHIRO KURAKU, RIKEN CDB, Kobe
MICHAEL HILLER, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden

Uncovering the Genomic Bases of Phenotypic Change in the NGS Era
Organizers: Manuel Irimia, Ignacio Maeso, Juan Pascual-Anaya
Speakers:
ANDREAS HEJNOL, Sars Centre for Marine Molecular Biology, Bergen
VINCENT J. LYNCH, University of Chicago
BORIS LENHARD, Imperial College London & MRC Clinical Sciences Centre, London
FRANK CHAN, Friedrich Miescher Laboratory of the Max Planck Society, Tübingen

"Living fossils," Myth or Reality?
Organizers: Patrick Laurenti, Didier Casane
Speakers:
PATRICK LAURENTI, CNRS & Université Paris-Diderot
HUGO DUTEL, RIKEN, Kobe & Muséum National d'Histoire Naturelle, Paris
GILLES CUNY, Muséum National d'Histoire Naturelle & University of Copenhagen
SHIGERU KURATANI, RIKEN & University of Kobe

EvoDevo of Colour
Organizers: Beverley Glover
Speakers:
EDWIGE MOYROUD, University of Cambridge
HESTER SHEEHAN, University of Bern
TALLINE MARTINS, Duke University, Durham
BENJAMIN PRUD´HOMME, CNRS & Institut de Biologie du Développement, Marseille

"NEPTUNE" ITN: The Evolution of Sensory Systems in the Marine Environment
Organizers: Maria Ina Arnone, Andreas Hejnol
Speakers:
ZBYNEK KOZMIK, Institute of Molecular Genetics, Prague
GÁSPÁR JÉKELY, Max Plank Institute for Developmental Biology, Tübingen
YALE PASSAMANECK, University of Hawaii
KEVIN PANG, University of Bergen

Mechanical Mechanisms of Development
Organizers: Annemiek Cornelissen, Naomi Nakayama
Speakers:
MALCOLM BENNETT, University of Nottingham
THOMAS GREB, Gregor Mendel Institute of Molecular Plant Biology, Vienna
CARL-PHILIPP HEISENBERG, Institute of Science and Technology, Klosterneuburg
VINCENT FLEURY, Laboratory of Complex Matter and Systems, Paris
OLIVIER HAMANT, Laboratoire de Reproduction et Développement des Plantes, Lyon
PIERRE-FRANÇOIS LENNE, Developmental Biology Institute of Marseille
STÉPHANE DOUADY, Laboratory of Complex Matter and Systems, Paris
DEREK MOULTON, University of Oxford

56 **The Roche Discovery Oncology Symposium: Perspectives on Wnt signaling**
Organizers: Wim Damen, Cornelius Eibner
Speakers:
MADELON MAURICE, University Medical Center Utrecht
MICHEL VERVOORT, Institut Jacques-Monod, Paris
TERESA ADELL, University of Barcelona
CLAUDIO CANTÙ, University of Zurich

Origin and Diversification of Regeneration
Organizer: Florian Raible
Speakers:
BRIGITTE GALLIOT, University of Geneva
JOCHEN RINK, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden
NIPAM PATEL, University of California, Berkeley
JEREMY BROCKES, University College London

Towards an Extended Evolutionary Synthesis
Organizers: Gerd Müller, Werner Callebaut
Speakers:
KEVIN LALAND, University of St. Andrews
EÖRS SZATHMÁRY, Eötvös Loránd University, Budapest
ETIENNE DANCHIN, INRA & CNRS, Toulouse
Werner CALLEBAUT, The KLI Institute

Quo vadis EvoDevo?
Organizers: Manfred D. Laubichler, Cassandra Extavour
Speakers:
CASSANDRA EXTAVOUR, Harvard University
JOHANNES JAEGER, Centre de Regulacio Genomica, Barcelona
MANFRED LAUBICHLER, Arizona State University

EvoDevo of Symmetry in Animals and Plants
Organizers: Sophie Nadot, Catherine Damerval
Speakers:
VINCENT DEBAT, Muséum National d'Histoire Naturelle, Paris
STÉPHANE NOSELLI, Institut de Biologie Valrose, INSERM, Nice
SABINE ZACHGO, University of Osnabrück
FLORIAN JABBOUR, Muséum National d'Histoire Naturelle, Paris

Plant EvoDevo - Linking Cross-species Genetic & Morphological Variation

Organizers: John Bowman, Christian Hardtke

Speakers:

CHRISTIAN HARDTKE, University of Lausanne

FRANCOIS PARCY, CNRS, Grenoble

DEVIN O'CONNOR, University of Cambridge

MILTOS TSIANTIS, Max Planck Institute for Plant Breeding Research, Cologne

What Should Bioinformatics Do for EvoDevo?

Organizers: Paula Mabee, Mark Blaxter, Ann Burke,Günter Plickert

Speakers:

PAULA MABEE, University of South Dakota

SUJAI KUMAR, University of Oxford

PHILIPP SCHIFFER, University of Cologne

CHRISTOPHER KRAUS, University of Cologne

CHELSEY SPECHT, University of California, Berkeley

PHILIP DONOGHUE, University of Bristol

KAREN SEARS, University of Illinois

MEGAN WILSON, University of Otago

Structural Organization in Vertebrate Dentitions: Molecules, Morphology and Function

Organizers: Moya Smith

Speakers:

ZERINA JOHANSON, Natural History Museum, London

ELODIE RENVOISE, University of Helsinki

MARCELA BUCHTOVA, University of Veterinary and Pharmaceutical Sciences, Brno

XAVIER JORDANA, Institut Català de Paleontologia Miquel Crusafont, Barcelona

EvoDevo as an Approach to Understanding Communication: Modeling, Genetics, and Developmental Research in Vocal Communication and Its Neurological Underpinnings

Organizers: Ulrike Griebel, D. Kimbrough Oller

Speakers:

DAN DEDIU, Max Planck Institute for Psycholinguistic Research, Nijmegen

SONJA VERNES, Max Planck Institute for Psycholinguistic Research, Nijmegen

ANNE S. WARLAUMONT, University of California, Merced

KIMBROUGH OLLER & ULRIKE GRIEBEL, University of Memphis, TN

58 **Workshop**

Advances in Live Imaging Morphogenesis
Organizers: Frederike Alwes, Carsten Wolff
Speakers:
VAN HUISKEN, Max Planck Institute, Dresden
METTE HANDBERG-THORSAGER, Max Planck Institute, Dresden
PRADEEP DAS, ENS Lyon
ANASTASIOS PAVLOPOULOS, Janelia Farm Research Campus
JACQUES PAYSAN, Carl Zeiss AG
PAVEL TOMANCAK, Max Planck Institute, Dresden

Venice Workshop on Explaining Development 9 – 10 September 2014

Istituto Veneto di Scienze, Lettere ed Arti, Venice

Organization: Alessandro Minelli (University of Padova & Istituto Veneto di Scienze, Lettere ed Arti) and Thomas Pradeu (Paris-Sorbonne University and Institut Universitaire de France)

What is development, and how should it be explained? Conceptual issues play an important role in today's developmental biology (e.g., concerning plasticity and robustness, the periodization of development, etc.). An important, related question is to determine whether developmental biology offers theories. In a volume published by OUP in 2014 and edited by Minelli and Pradeu (Towards a theory of development), prominent biologists and philosophers have examined this question. This exploration of the theoretical aspects of developmental biology has now naturally led us to a broader and perhaps even more fundamental question, that of the explanation(s) of development.

Program

ALESSANDRO MINELLI
University of Padova & Istituto Veneto di Scienze Lettere ed Arti
THOMAS PRADEU
Paris-Sorbonne University & Institut Universitaire de France
Welcome and Introductory Remarks

Explaining What? – Putting Development in Context

GIUSEPPE FUSCO
University of Padova
Development in the Context of the Life Cycle

JAMES R. GRIESEMER
University of California, Davis
Periodization of Development

Explaining What? – Unconventional Developmental Systems

ALESSANDRO MINELLI
University of Padova & Istituto Veneto di Scienze Lettere ed Arti
The Development of the Fruit, the Seed, the Moss, and Other Chimaeric Systems

ALEXANDER V. ERESKOVSKY
CNRS, Aix Marseille University
Problems and Insights from Sponge Developmental Biology

What Is the Respective Role of Descriptions, Explanations, and Predictions in Developmental Biology?

THOMAS PRADEU
Paris-Sorbonne University & Institut Universitaire de France
Description, Explanation, and Prediction in Developmental Biology

LUCIE LAPLANE
Hopital Gustave Roussy et Université Paris 1 Panthéon-Sorbonne
Contrasting Notions of Theory and their Relevance for Developmental Biology

On the Causality of Development

WALLACE ARTHUR
National University of Ireland, Galway
Topology of Causal Links in Development

JOHANNES JAEGER
Centre de Regulacio Genomica, Barcelona
The Role of Dynamical Systems Theory in a Mechanistic Theory of Development

GERD B. MÜLLER
The KLI Institute & University of Vienna
Do Theories of Evolution Affect Theories of Development?

What Does It Exactly Mean to Give an Explanation of Development?

ALAN C. LOVE
University of Minnesota
The Concept of Potentiality in Developmental Reasoning

MICHEL VERVOORT
Institut Jacques-Monod, Paris
The Importance to Compare Convergent Developmental Processes in Trying to Establish Some Principles of Development

3.4 KLI Colloquia

KLI Colloquia are informal, public talks taking place at the new KLI institute in Klosterneuburg. Abstracts of the presentations and information about the lecturers can be found at the website of the institute.

BRIAN McLOONE
The KLI Institute & University of Wisconsin, Madison
How Collaboration Develops in Humans: Empirical and Game Theoretic Perspectives

RIK PINXTEN
Ghent University
The Creation of God

JOHN DUPRÉ
Egenis, University of Exeter
Adaptation: Beyond the Structure/Function Dichotomy

MATHIEU CHARBONNEAU
The KLI Institute
The Cultural Genotype-Phenotype Distinction and the Technical Constraints on the Generation of Cultural Variation

DENIS WALSH
University of Toronto
Chance Caught on the Wing: Metaphysical Commitment or Methodological Artefact?

HASOK CHANG
University of Cambridge
Temperature: From Quality to Quantity

RACHAEL BROWN
University of Western Ontario
Impossible Cultures? Exploring the Applicability of EvoDevo to Cultural Evolution

ARGYRIS ARNELLOS
The KLI Institute
Multicellular Systems and Organismal Action

62 FRED KEIJZER
The KLI Institute & University of Groningen
Early Nervous Systems and the Origins of the Animal Sensorimotor Organization

FEDERICA TURRIZIANI COLONNA
The KLI Institute & Arizona State University, Tempe
Shedding Light on the Zoological Station in Trieste

JOERI WITTEVEEN
Utrecht University
Rethinking "Population Thinking"

IÑIGO ONGAY DE FELIPE
Deusto University, Bilbao
The Role of Behavior in Evolution: Or How to Take the Operations of Organisms Seriously (and Yet Not Be a Lamarckian)

LUKAS LANDLER
Virginia Tech
Stay in Line: Magnetoreception, Symbiosis, and Woodpecker Cavities

EVELINE SEGHERS
The KLI Institute & Ghent University
Joint Observation of Visual Arts Facilitates Within-group Cooperation

MICHAEL SCHUBERT
Laboratoire de Biologie du Développement de Villefranche-sur-Mer
The Cephalochordate Amphioxus: A Model for Understanding Animal Evolution and Developmental Mechanisms?

KAREL KLEISNER
Charles University in Prague
The Role of Perceptual Variation in the Evolution of Semantic Organs

Publications

4

Scientific publications

and presentations

of fellows and staff members

of the KLI in 2014.

4.1 Professional Papers and Books

ALTENBERG L.
Mathematics Awaits: Commentary on "Genetic Programming and Emergence" by Wolfgang Banzhaf
Genetic Programming and Evolvable Machines 15: 87-89

ALTENBERG L.
Evolvability and Robustness in Artificial Evolving Systems: Three Perturbations
Genetic Programming and Evolvable Machines 15: 275-280

BAETU TM.
Models and the Mosaic of Scientific Knowledge. The Case of Immunology
Studies in History and Philosophy of Biological and Biomedical Sciences 45: 49-56

BARWICH A-S.
A Sense So Rare: Measuring Olfactory Experiences and Making a Case for a Process Perspective on Sensory Perception
Biological Theory 9: 258-268

BOUDRY M, VLERICK M.
Evolution Does Care About Truth
International Studies in the Philosophy of Science 28: 65–77

BOUDRY M, VLERICK M, McKAY RT.
Can Evolution Get Us off the Hook? Evaluating the Ecological Defence of Human Rationality
Consciousness and Cognition 33: 524–535

CALLEBAUT W.
Some Contemporary Elaborations of Darwinian Themes [Editorial]
Biological Theory 9: 251-252

CALLEBAUT W.
Beyond a "Levels View" of Science
Constructivist Foundations 10: 79-80

66 CAPEK D, METSCHER BD, MÜLLER GB.
Thumbs Down: A Molecular-Morphogenetic Approach to Avian Digit Homology
Journal of Experimental Zoology Part B (Molecular and Developmental Evolution) 322: 1-12

CHARBONNEAU M.
Populations Without Reproduction
Philosophy of Science 81: 727-740

EL MOUDEN C, ANDRÉ JB, MORIN O, NETTLE D.
Cultural Transmission and the Evolution of Human Behaviour: A General Approach Based on the Price Equation
Journal of Evolutionary Biology, 27: 231-241

LALAND K, ULLER T, FELDMAN M, STERELNY K, MÜLLER GB, MOCZEK A, JABLONKA E, ODLING-SMEE J, WRAY JA, HOEKSTRA HE, FUTUYMA DJ, LENSKI RE, MACKAY TFC, SCHLUTER D, STRASSMANN JE.
Does Evolutionary Theory Need a Rethink?
Nature 514: 161-164

LANGE A, NEMESCHKAL HL, MÜLLER GB.
Biased Polyphenism in Polydactylous Cats Carrying a Single Point Mutation: The Hemingway Model of Digit Novelty
Evolutionary Biology 41: 262-275

MATUSZEWSKI S.
The Genetics of Adaptation in Changing Environments
PhD thesis, University of Vienna

MATUSZEWSKI S, HERMISSON J, KOPP M.
Fisher's Geometric Model with a Moving Optimum
Evolution 68: 2571-2588

McGHEE G.
When the Invasion of Land Failed. The Legacy of Devonian Extinction
New York: Columbia University Press

MORIN O.
Is Cooperation a Maladaptive By-product of Cultural Transmission? Simon's Docility Hypothesis Reconsidered
Biological Theory 9: 286-295

MORIN O.
The Virtues of Ingenuity: Reasoning and Arguing Without Bias
Topoi: An International Review of Philosophy 33: 499-512

MORIN O.
Comment la psychologie pourrait être utile aux historiens
Tracés: revue de sciences sociales, Special issue 14: Traduire/Introduire: 139-150

MORIN O.
A Review of P. Déléage, Inventer l'Écriture & Le Geste et l'Écriture
Social Anthropology 20: 122-123

MASCARO O, MORIN O.
Gullible's Travel: How Honest and Trustful Children Become Vigilant Communicators
In: Trust and Skepticism: Children's Selective Learning From Testimony (Robinson L, Einav S, eds.) pp. 69-83
New York: Psychology Press

MITTEROECKER P, MAYER C, METSCHER BD, MÜLLER GB.
Studying Developmental Variation with Geometric Morphometric Image Analysis
PLoS ONE 9: e115076

MORIN O.
Why Cultural Transmission Is Selective and Cost-sensitive, and What Difference It Makes
In: Naturalistic Approaches to Culture (Pléh C, Richerson P, Csibra G, eds.), pp. 89-101
Budapest: Akadémiai Kiadó

MÜLLER GB.
EvoDevo Shapes the Extended Synthesis [Editorial]
Biological Theory 9: 119-121

68 NOBLE D, JABLONKA E, JOYNER MJ, MÜLLER GB, OMHOLT SW.
Evolution Evolves: Physiology Returns to Centre Stage
Journal of Physiololgy 592: 2237-2244

NUÑO DE LA ROSA L.
On the Possible, the Conceivable, and the Actual in Evolutionary Theory. A Critical Review of Gustavo Caponi's Requiem for the Centaurus
Biological Theory 9: 221-228

NUÑO DE LA ROSA L, MÜLLER GB, METSCHER BD.
The Lateral Mesodermal Divide: An Epigenetic Model of the Origin of Paired Fins
Evolution & Development 16: 38-48

RASSKIN-GUTMAN D, ESTEVE-ALTAVA B.
Connecting the Dots: Anatomical Network Analysis in Morphological EvoDevo
Biological Theory 9: 178-193

WATSON RA, WAGNER GP, PAVLICEV M, WEINREICH DM, MILLS R.
The Evolution of Phenotypic Correlations and Developmental Memory
Evolution

WINDHAGER S, SCHASCHL H, SCHAEFER K, MITTEROECKER P, HUBER S, WALLNER B, FIEDLER M.
Variation at Genes Influencing Facial Morphology Are Not Associated with Developmental Imprecision in Human Faces
PLoS ONE 9: e99009

XENAKIS I, ARNELLOS A.
Aesthetics as an Emotional Activity that Facilitates Sense-making: Towards an Enactive Approach to Aesthetic Experience
In: Aesthetics and the Embodied Mind: Beyond Art Theory and the Cartesian Mind-Body Dichotomy (Scarinzi A, ed.)
Dordrecht: Springer

XENAKIS I, ARNELLOS A.
Aesthetic Perception and Its Minimal Content: A Naturalistic Perspective
Frontiers in Psychology 5: 1-15

4.2 Forthcoming Publications

ALTENBERG L.
Mathematical Errors Invalidate the Bad Prognosis for Prevention
Science

ARNELLOS A, MORENO A.
Multicellular Agency: An Organizational View
Biology and Philosophy

ARNELLOS A, MORENO A.
Integrating Constitution and Interaction in the Transition from Unicellular to Multicellular Organisms
In: The Origins and Consequences of Multicellularity (Niklas K, Newman S, eds)
Cambridge, MA: MIT Press

ARNELLOS A.
Book Review of "On the Origin of Autonomy. A New Look at the Major Transitions in Evolution" by Bernd Rosslenbroich
Biological Theory

ARNELLOS A, EL-HANI C.
Emergence, Downward Determination, and Brute Facts in Biological Systems
In: Brute Facts Anthology. (Vintiadis E, Mekios C, eds.)
New York: Oxford University Press

ARNELLOS A.
From Processes to Autonomous Biological Organizations
In: Process Philosophy of Biology (Dupre J, Nicholson D, eds.)
New York: Oxford University Press

BAETU TM.
When Is a Mechanistic Explanation Satisfactory? Reductionism and Antireductionism in the Context of Mechanistic Explanations
In: Romanian Studies in the History and Philosophy of Science
(Sandu G, Parvu I, Toader I, eds.)
Dordrecht: Springer

BAETU TM.
The Completeness of Mechanistic Explanations
Philosophy of Science

BAETU TM.
From Mechanisms to Mathematical Models and Back to Mechanisms: Quantitative Mechanistic Explanations
In: Explanation in Biology (Malaterre C, Braillard P-A, eds.)
Dordrecht: Springer

BAETU TM.
The "Big Picture": The Problem of Extrapolation in Basic Research
British Journal for the Philosophy of Science

BARWICH A-S.
Bending Molecules or Bending the Rules? The Application of Theoretical Models in Fragrance Chemistry
Perspectives on Science

BARWICH A-S, CHANG H.
The Problem of Coordination ≠ the Problem of Standardization: What Sensory Measurement Is (Not)
Biological Theory

BARWICH A-S
What Is So Special About Olfaction? Odour Receptors, Ligand Binding Complexity, and the Evolution of Signalling Proteins
Postgraduate Medical Journal

BARWICH A-S
Book Review of Experiments in Practice (History and Philosophy of Technoscience) by Astrid Schwarz
Journal of the History of Science Society

BARWICH A-S, FIRESTEIN S.
The Systematicity of Ignorance? Science and Its Quest for the Yet Unknown
In: Systematcity (Bschir K, Lohse S, Chang H, eds.)
Synthese

BARWICH A-S

EvoDevo and Olfaction: Developing Process Categories for Perception

Workshop Proceedings of "Process Philosophy of Biology" Meeting in Exeter
New York: Oxford Universoty Press

BARWICH A-S

Is Captain Kirk a Natural Blonde? Comparing Model-based Inferences in Science and Fiction Theory

Workshop Proceedings "Shaping the Trading Zone: Bringing Aesthetics and Philosophy of Science Together" (French S, Bueno O, Thomas D, eds.)
New York: Oxford University Press

BIRNER J.

Generative Mechanisms and Decreasing Abstraction

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EvoDevo Shapes the Extended Synthesis [Editorial]

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Identifying Beharioral Novelty

FLAMENT-FULTOT M.
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4.4 Scientific Presentations

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The Role of Gene Origin in the Evolution of Evolvability
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ALTENBERG L.
The Evolution of Evolvability: The Role of Gene Origin
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Fisher's "Deterioration of the Environment," and the Evolution of Information Transmission
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The Evolution of Evolvability
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Multicellular Systems and Organismal Action
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31st Altenberg Workshop in Theoretical Biology, The KLI Institute, Klosterneuburg

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3rd European Advanced Seminars in the Philosophy of Life Sciences (EASPLS), The KLI Institute, Klosterneuburg

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An Organizational Approach to Organisms

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Lab Excursion of Cognitive Science Students of the University of Vienna, The KLI Institute, Klosterneuburg

BARWICH A-S.

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Commentary on "Ontologies of Protein-Ligand Binding Complexes" (I. Sarto-Jackson)

3rd European Advanced Seminar in the Philosophy of the Life Sciences (EASPLS), The KLI Institute, Klosterneuburg

BARWICH A-S.

EvoDevo and Olfaction: Developing Process Categories for Perception

Process Philosophy of Biology, Exeter

BARWICH A-S.
How Philosophy Matters to Science (And Why You Shouldn't Listen to Philosophers. Talk to Them.)
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A Fine Nose for Timeliness: The Discovery of the Olfactory Receptors and the Question of Novelty
Philosophy of Science Association 2014 Meeting, Chicago

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Is Captain Kirk a Natural Blonde? The Limits of Fiction and What They Can Tell us about Modeling in Science
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A Whiff of the Unknown: Contemporary Issues in Olfaction
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BLASCO MANEZ T, BALARI S, LORENZO G.
Language Acquisition as an Organic Developmental Process
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Philosophy of Culture to Combat Analytical Scholasticism
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A Short History of Quality
30th Altenberg Workshop in Theoretical Biology "Quality & Quantity: Limits of Quantification in the Sciences," The KLI Institute, Klosterneuburg

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The Role of EvoDevo in Extending the Evolutionary Synthesis
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CHARBONNEAU M.
Mechanical Molecular Models and Haptic Reasoning
Integrated History and Philosophy of Science, University of Vienna

CHARBONNEAU M.
The Cultural Genotype-Phenotype Distinction and the Technical Constraints on the Generation of Cultural Variation
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CHARBONNEAU M.
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CHARBONNEAU M.
Evolutionary Developmental Considerations on Cultural Inheritance
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CHARBONNEAU M.
Commentary on "The Limited Extended Nature of Biological Inheritance" (F. Merlin)
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CHIU LC-H.
Niche Construction and Rethinking the Dichotomy of Exernalist/ Internalist Evolutionary Explanations
Lab Excursion of Cognitive Science Students of the University of Vienna, The KLI Institute, Klosterneuburg

KEIJZER FA.
The Skin Brain Thesis: A Conceptual and Modeling Approach
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Rapid Evolution of Quantitative Traits: Theoretical Perspectives
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MAYER C, METSCHER BD, MÜLLER GB, MITTEROECKER P.
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Two Questions Worth Asking about Cultural Transmission
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MORIN O.
Three Dimensions of the Cultural Exploitation of the Human Mind
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Catholic University of Ghent

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In Praise of Shmeasurement: What We are Doing When We Are Not Quantifying
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Cardinality and the Evolution of Writing Systems
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What´s in a Letter?
Lab Excursion of Cognitive Science Students of the University of Vienna,
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MÜLLER GB.
Experimentalzoologie und die Grundlagen der Theoretischen Biologie
The Centennial of the Institute for Experimental Biology in Vienna,
Austrian Academy of Sciences, Vienna

MÜLLER GB.
What Kind of Theory for Development?
Workshop on Explaining Development, Istituto Veneto di Scienze,
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MÜLLER GB.
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3rd European Advanced Seminar on the Philosophy of the Life Sciences (EASPLS),
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Cellular Slime Moulds and the Transition from Unicellular to Multicellular Life
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Rethinking Typology and Teleology in Evolutionary Biology
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NUÑO DE LA ROSA GARCÍA L.
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Commentary on "Evolutionary Novelty–A Concept Still in Search of a Definition" (T. Racovski) and "Emergent Properties in an EvoDevo Biological Concept" (V. Triviño Alsono)
3rd European Advanced Seminar in the Philosophy of the Life Sciences (EASPLS), The KLI Institute, Klosterneuburg

NUÑO DE LA ROSA GARCÍA L, TRIVIÑO ALONSO V.
The Return of Potencies in Evolutionary Biology. Towards an Ontology of Possibility
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NUÑO DE LA ROSA GARCÍA L.
Designing Life? On the Epistemological and Ontological Assumptions of Synthetic Biology
Lab Excursion of Cognitive Science Students of the University of Vienna,
The KLI Institute, Klosterneuburg

PETERSON T, MÜLLER GB.
The Origination of Novelty: Qualitative Changes from Quantitative Variation
5th Meeting of the European Society for Evolutionary Developmental Biology (Euro Evo Devo), University of Vienna

SARTO-JACKSON I.

Transgressing the Borders of Quantification by Data Visualization

30th Altenberg Workshop in Theoretical Biology "Quality & Quantity: Limits of Quantification in the Sciences," The KLI Institute, Klosterneuburg

SARTO-JACKSON I.

Ontologies of Protein-Ligand Binding Complexes

3rd European Advanced Seminar on the Philosophy of the Life Sciences (EASPLS), The KLI Institute, Klosterneuburg

SARTO-JACKSON I.

An Alternative View on Learning and Memory Formation

Lab Excursion of Cognitive Science Students of the University of Vienna, The KLI Institute, Klosterneuburg

Further Activities

5

Many activities of the KLI exceed the scientific core agenda. Some representative activities are listed here.

5.1 Relocation of the KLI

In January 2014, the KLI Institute moved from the Lorenz mansion in Altenberg to its new premises in Klosterneuburg. The institute building now offers an excellent infrastructure for fellows and guests for pursuing their own research projects, and provides ample space for scientific events. Two workshops, one summer school, 16 KLI Colloquia, and a public art performance already took place at the new KLI, last year.

On 26 June 2015, the official opening of the new KLI building will be celebrated.

5.2 Biological Theory

Due to Werner Callebaut's devoted efforts as editor-in-chief of *Biological Theory,* the journal is in impeccable condition, completely up-to-date, and at a high level of quality. After Werner Callebaut´s untimely passing, the KLI and Springer acted quickly in finding a worthy successor. Stuart Newman from the New York Medical College and external faculty of the KLI has agreed to take on the role of editor-in-chief. Stuart is a theoretical and developmental biologist with long-term interests in the philosophy of biology, linguistics, and the social and cultural implications of biological research. He has served on the editorial board of *Biological Theory* since the journal's founding. In addition, Isabella Sarto-Jackson, executive manager of the KLI, molecular biologist, and neuroscientist joined the board of associate editors.

5.3 Public Outreach Activities

Theory of Flight – Research Meets Fantasy 26 July 2014

The KLI Institute, Klosterneuburg

Organization: Anna Lindemann (Boston) and the KLI Institute

The KLI hosted "Theory of Flight," a performance by Anna Lindemann, a composer and artist trained in evolutionary and developmental biology. In a twist on the ancient myth of Icarus, a lecturing scientist reveals she has been growing her own wings using avian genes. Animated chalkboard diagrams convey the molecular biology, while vocal music and animated silhouettes advance the plot, about the risks and rewards of pursuing impossible research. Anna Lindemann´s piece "Theory of Flight" combines digital and stop-motion animation, live and electronic music, video, and performance to explore the emerging field of EvoDevo. Anna Lindemann is committed to illuminating the intersections of art and science for students and audiences from young to old.
The performance was part of the after-conference program of the Euro Evo Devo Meeting 2014 in Vienna.

About the artist

Anna Lindemann (composer, animator, writer, performer) creates work that integrates multi-disciplinary art and biology. Anna graduated magna cum laude from Yale University with a B.S. in Biology. She conducted field research on bird speciation and bird calls in Indonesia. Anna taught digital art as a Visiting Assistant Professor in the Department of Art and Art History at Colgate University during the 2011-2012 academic year. She is currently a program mentor for teenagers participating in the Boston ArtScience Prize.

European Researchers' Night 4th April 2014

IST Austria, Klosterneuburg

Organization: State Government of Lower Austria

The KLI also participated in the European Researchers´ Night that was organized by the Office of the State Government of Lower Austria. The European Researchers´ Night is a Europe-wide public event dedicated to popular science and fun learning. More than 30 countries and over 300 cities are involved. The events showcase what researchers really do for society, in interactive and engaging ways, and promote research careers to young people and their parents.

5.4 Acknowledgment

The KLI is grateful to the Office of the State Government of Lower Austria, Division for Science and Research for additional financial support contributing to the scientific endeavors of the KLI.