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Review 2017 and Structure of the KLI

Through its in-house activities, workshops, and seminar series the KLI has uniquely provided a context for rethinking major questions in developmental, cognitive, and evolutionary biology.

Stuart A. Newman
(New York Medical College)

1.1 The Year in Review

Looking back, 2017 was an extraordinarily eventful year. The successful format of the Altenberg Workshops in Theoretical Biology was continued with workshops on the "Causal Foundations of Biological Information" and on "A Revised Theory of Cancer." The latter also spurred a public event, organized at the University of Vienna, that attracted a large audience. Furthermore, the KLI hosted a workshop on "Causes and Processes in Evolution" that was organized within the framework of a multinational, interdisciplinary project concentrating on the development of an 'Extended Synthesis' in evolutionary theory and that includes eight leading academic institutions. In addition, the first KLI Focus Group, hosted in September, entitled "Synthesizing (a Kind of) Life," included KLI Advisory Board member Eörs Szathmáry and KLI External Faculty member Stuart Kauffman. Moreover, the KLI co-sponsored a public symposium in Vienna on "Editing Genomes with CRISPR: Between Scientific Breakthroughs and Societal Challenges" in which KLI External Faculty member Stuart Newman gave a lecture that received remarkable coverage by the Austrian press. Several more cooperative events were organized, such as joint workshops with the Wissenschaftskolleg zu Berlin and the Lorentz Center in Amsterdam as well as a series of lab visits, retreats, and small workshops of a doctoral school from the University of Vienna. This very busy schedule was topped off by 34 KLI Colloquia and activities dedicated to "Arts & Science" that exhibited the work of Petra Maitz, Gemma Anderson, and Anton Herzl.

In addition to the events mentioned above, the KLI hosted a thriving community of 26 international fellows at the institute in 2017. The fellows and staff of the KLI published 37 books and articles and four issues of the journal Biological Theory, and gave 36 scientific presentations at international meetings. A new book entitled "Vivarium: Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt" was published in the Vienna Series in Theoretical Biology. It derived from the commemorative symposium "Hundert Jahre Biologische Versuchsanstalt" jointly organized by the KLI and the Austrian Academy of Science in 2014. With the extensive number of events, plus the administration of the large number of fellows and visitors and further chores not listed here, the staff of the KLI was more than fully occupied, and I wish to express my special thanks to Dr. Isabella Sarto-Jackson and Eva Lackner!

The detailed information on the activities of the KLI in 2017 in the pages of this report attests to a high level of activity made possible by the wonderful setting of the new institute building. As in all the years before, I am much obliged to the members of the KLI Trust, the Board of Directors, the Scientific Advisory Board, the members of the External Faculty as well as the staff and fellows of the KLI. Above all, my cordial thanks go to Traudl Engelhorn for her active interest in the development of the KLI and for her continued support.

Gerd B. Müller
President

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 five different categories; granting decisions are based on international peer review.

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

1.3 Organization of the KLI

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Department of Cell Biology and Anatomy, New York Medical College,
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Scientific Projects

The KLI offers 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 2017, the KLI received a total of 46 applications for fellowships, 15 of these were granted for 2017 or 2018, achieving an overall acceptance rate of 33%.

2.2 Writing-Up Fellowships

Tomáš EICHLER
(May – October 2017)

Tomas Eichler is a neurogeneticist trying to understand the mechanisms of how molecules, cells, brains and all of us behave. With the heart of a physiologist and a passion for teaching he hopes to spread science to the public, besides his scientific commitment in interdisciplinary research. He holds a Master´s degree in Genetics from Comenius University, Bratislava. He pursued his PhD in Molecular Biology & Neuroscicence at the Institute of Molecular Pathology (IMP), Vienna. He has been awarded a KLI Writing-Up fellowship to finalize his thesis on Neurogenetics: Neural & Molecular Basis of Behavior.

Learning How We Wake up from Excited Sleeping Worms

Experience tells us that sleep is vital, yet its biological functions are not entirely understood. During sleep, individuals give up opportunities to reproduce, eat, drink and socialize, and are more prone to predation. Sleep must therefore serve crucial primordial functions. Previous research suggests it has multiple roles, such as the regulation of synaptic plasticity or energy homeostasis. A lack of sleep diminishes daily performance and chronic sleep deprivation causes diseases. A better understanding of sleep and its underlying neural mechanisms is therefore a fundamental aim in biology with high medical

relevance. Sleep and sleep-like states are widespread across phylogeny, which opens up research opportunities with model organisms. Here I report a very powerful paradigm in a highly tractable genetic model organism, *C. elegans*, which will enable future studies to solve one of the biggest unresolved and debated mysteries in neuroscience: why do we sleep? And furthermore: Why and how do we wake up?

I investigate my recent discovery of an arousal regulator, that is an evolutionarily conserved hormone with so far unknown functions in humans, which is possibly a wake-up signal. I propose how it can activate our nervous systems and promote wakefulness.

Finally, *C. elegans* has been shown as a fruitful model for fundamental biological research attracting experts of various non-biology fields, including physicists and computer scientists. Why not promote *C. elegans* as a theoretical model organism to KLI fellows and visitors?

Eva FERNÁNDEZ-LABANDERA
(July 2017 – January 2018)

Eva Fernandez-Labandera Tejado is a PhD student from the University of the Basque Country (UPV / EHU) and works on her PhD thesis "Homeostasis, Stability and Regulation in a Systems Biology Framework: Conceptual Analysis from a Philosophical Perspective" (supervised by Arantza Etxeberria and Alvaro Moreno).

Homeostasis and Regulation in a Systems Biology Conceptual Framework

This work is an attempt to redefine the notion of homeostasis, from a philosophical perspective, in order to make it useful for the ongoing investigations about organisms and systems in the fields of biology, physiology, immunology, philo-

sophy, among others. In the first part, I´ll run a historical and philosophical analysis of the term, from Claude Bernard to Systems Biology; in the second part, I'll expose my own definition of homeostasis and some of the implications it might have in the actual debates about organism, on one hand, and on the definitions of health and disease, in the other. My hypothesis aims at demonstrating how compulsory such a redefinition is, and I´ll try to offer an alternative one, which might be useful both from a theoretical and from a practical perspective.

Sara MURILLO SÁNCHEZ
(October 2016 – March 2017)

Sara Murillo Sánchez is a PhD student at the Department of Logic and Philosophy of Science IAS-Research Group of the University of the Basque Country, San Sebastián. She has been awarded a KLI Writing-Up Fellowship to complete her thesis "About the Naturalization of the Concepts of Autonomy, Function and Agency in an Empirical-Theoretical Approach to the Origin of Minimal Cellular Systems."

A "Systems Chemistry" Approach for the Naturalization of Concepts in Biology

The understanding of the phenomenon of life has been always a main challenge for science. Traditionally, the evolutionary framework, in which life is conceived from a historical and collective point of view, has had higher weight; however, the organizational perspective, which looks for general principles underlying biological individuals (cellular organisms in particular), is gaining momentum during the last years, especially after the emergence of systems biology. This tension is also apparent within the origins of the life research field, where there are very important difficulties to account for the transition from the chemical (molecular) to the biological (cellular) domain

according to a classical evolutionary scenario (i.e., selection algorithms applied to populations of 'replicating' chemical species). In this context, a new sub-discipline has recently been launched in Europe, called 'systems chemistry,' whose aim is the scientific study of complex mixtures of molecules and their emergent (dynamic and evolutionary) behaviors, which could change the state of affairs, providing the right platform to tackle the origin-of-life problem. This PhD is an attempt to contribute to that general goal, showing that there is very interesting and fertile ground to explore various connections between systems biology and systems chemistry. More precisely, my claim is that fundamental concepts in biological explanations, like function or information, which have an intrinsic relational character (i.e., ought to be understood in terms of relationships among molecular components), should be naturalized through a genealogical approach to biological complexity, starting from its chemical roots. In other words, I will defend that origins-of-life research, if tackled from a systems standpoint (like systems chemistry aims to do), is bound to provide key insights for theoretical biology, both from an organizational and an evolutionary perspective.
I have worked in the development of an empirical protocellular model that may bring some light into several aspects related to the emergence of cellular organization.

Through that experimental model, my objective is to illustrate how the first steps towards biological individuality and function could be addressed in a chemical context. In addition, on more general grounds, this PhD is an appeal to transciplinarity in science. In fact, the experimental work carried out was designed from a previous theoretical model, which in turn was based on philosophical reflection around the problem of origins of life. On these lines, we will claim that philosophical work, if properly channeled, can reinforce science and vice-versa. This leads to a new conception of philosophy of science (philosophy for science), which will be suggested as the most promising option for philosophy to play a relevant role in the future generation of human knowledge.

Murillo PAGNOTTA
(August 2017 – February 2018)

Murillo Pagnotta holds a B.Sc. in Biology and a M.Sc. in Experimental Psychology. He is currently finishing his PhD thesis (under the supervision of Kevin Laland) at the University of St. Andrews. He has worked as a science teacher and as editor and science writer in Brazil. Murillo was awarded a KLI Writing-Up Fellowship to complete his PhD thesis.

Towards a Relational-Processual Approach to Social Learning and 'Culture'

In many species, learning or skill development, may be influenced by the presence and the behaviour of other individuals, or the products of their behaviour. The term 'social learning' is currently used to refer to such processes which include teaching, imitation, emulation, stimulus enhancement, and local enhancement. Processes of social learning underlie the 'passing on' of knowledge and behaviour among individuals within and across generations. This can lead to what is now commonly called behavioural 'traditions' or 'culture' in humans and nonhuman animals. In my thesis, I focus on social learning and 'culture' in two complementary investigations. The conceptual-theoretical investigation follows from a dissatisfaction with how the currently dominant approaches to social learning are supported by, and in turn reinforce, info-centric views of development, inheritance, evolution, cognition, and 'culture'. I will therefore clarify the use of the term 'information' in these contexts. I will also review and begin to integrate three relational and process-oriented alternative frameworks which may provide an innovative and consistent way of thinking about social learning and 'culture'. They include 'developmental systems theory' in biology, 'radical embodiment approach' in the cognitive sciences, and 'relational thinking' in anthropology. The experimental investigation applies this relational-processual framework to examine the coordination of visual attention in child-instructor dyads during a joint making task.

Nadia SCOTT
(February – June 2017)

Nadia Scott is a PhD student of Biological Sciences at the Max Planck Institute for Evolutionary Anthropology, Department of Human Evolution, Leipzig, Germany. She has received a KLI Writing-Up Fellowship to complete her PhD thesis.

Comparative Endocranial Development in Primates

By comparing species-specific developmental patterns, we can approach the question of how development shapes adult morphology. We focus here on shape change trajectories of the primate endocranium, an integrated system that arises as the result of a complex interplay between bone, meninx and the expanding brain. Previously, we have shown that the pattern of endocranial development in modern humans deviates from that of chimpanzees (Neubauer et al., 2010) and Neanderthals during the first year of life (Gunz et al., 2010; 2012), but subsequently reverts to an ontogenetic pathway shared by all three groups. To explore whether this ontogenetic pattern is shared among extant hominoid species, we characterised and compared shape changes of the endocranium from infancy (erupted deciduous dentition) to adulthood in a cross-sectional sample of modern humans (n=87), chimpanzees (n=59), gorillas (n=67), orangutans (n=75) and gibbons (n=21). On virtual endocasts generated by segmenting computed tomographic scans of dried crania, we measured 29 three-dimensional endocranial landmarks as well as several hundred semilandmarks on curves and the endocranial surface. Following sliding of semilandmarks, Procrustes superimposition was used to standardize location, orientation and scale. To account for the non-linearity of the developmental trajectories, we determined the similarities of ontogenetic patterns between species by interchanging their ontogenetic trajectories. The results of our developmental simulations indicate that, from the eruption of complete deciduous dentition, the patterns of endocranial development are similar among hominoids, but differ in the amount

of shape change produced. To determine to what degree endocranial development is independent of facial development, we performed partial least squares analyses on our great ape data, which allows us to examine the interdependence of two or more developmental modules. Using the face and the endocranium as separate modules, our results indicate that evolutionary integration is similar between species, indicating that development is highly conserved between species. Developmental integration, however, differs with ontogeny, transitioning from a weakly integrated period during infancy to a highly integrated period from the eruption of the deciduous dentition onwards. Our results indicate that early changes to the face are not translated to the endocranium, but that later changes occur in tandem between the two developmental modules.

Roland ZIMM
(October 2017 – April 2018)

Roland Zimm studies evo-devo questions using mathematical models. In particular, he is interested in relating development with patterns of phenotypic variation. He completed his Biology studies at the Technical University of Dresden with a theoretical model of cell type transdifferentiation to join Isaac Salazar-Ciudad's group at Helsinki University. Currently, he is finishing his PhD at the KLI.

On the Origins of Stability, Complexity, and Novelties: Insights from a General Model of Development

The theory of the emergence of novelty, complexity and robustness in evolution could benefit from an understanding of the dynamics of development. I use a general multiscale computational model of development that includes all the cell behaviors and soft-matter bio-mechanical properties known in animal cells and tissues. This model also implements gene regulatory networks (GRNs), of any topology, that can affect

mechanical properties and interactions of cells and tissues. By means of this model, I explore the range of embryonic morphologies that can arise in animal development. In the emerging morphospace, I study the diversity, complexity, and stability of morphologies. Preliminary results indicate that GRNs with extensive cell-cell signaling tend to increase morphological robustness, but not complexity. This can be related to the changing role of GRNs in the early stages of the evolution of complex multicellular organisms, in line with theories by Müller and Newman. Furthermore, I address the problem of the much-discussed hourglass model of developmental variation by connecting it to developmental mechanisms.

2.3 Postdoctoral Fellowships

Wesley Herb ANDERSON
(July 2016 – August 2017)

Wesley Herb Anderson holds a Bachelor´s degree in Philosophy from Portland State University and a Master´s degree in Philosophy from the University of Wisconsin, Milwaukee. He completed his PhD in History and Philosophy of Science at Arizona State University, Tempe. His PhD thesis was on "Advancing the Causal Theory of Natural Selection: Theory and Methodology" under the supervision of Brad Armendt.

Demography, Causal Structure, Evolutionary Dynamics, and Novelties

The goal of the project is two-fold. First, I aim to provide the conceptual resources necessary for thinking about novelties that arise from niche construction and phenotypic plasticity. The Modern Synthesis provides no such framework. In particular, insofar as novelties are understood as a subset of adaptations

where the trait was non-homologous in the lineage before fixation, then no conceptual sense can be made of novelties arising from niche construction or phenotypic plasiticty. This is because the traditional account of adaptation assumes the trait evolved in a common environment, which is unlikely in either the case of niche construction or phenotypic plasiticity.

Second, I aim to develop the formalization necessary for analyzing the evolutionary dynamics of systems undergoing niche construction and phenotypic plasticity (i) when demographic conditions are being constructed by traits or causing traits to develop and (ii) when both offspring dispersal and frequency-dependent selection are local only. We currently have no agreed upon machinery for doing so. Moreover most work on niche construction and phenotypic plasticity assume that offspring dispersal is always global. Of primary interest in this work is whether the causal direction between traits and demographic conditions will change the evolutionary dynamics in interesting ways, and whether global or local dispersal and frequency-dependent selection favor the evolution of different kinds of novelties—thus revealing demographic features of mechanisms of innovation.

In short, the project is in line with theoretical work on The Extended Synthesis at the intersection of philosophy of evolutionary biology and mathematical evolutionary biology.

Riana Juhn BETZLER
(October 2016 – September 2018)

Riana Betzler holds a Bachelor´s degree in Psychology from Yale University, New Haven, CT. She studied at the European College of Liberal Arts in Berlin and did her Master´s Degree in Philosophy on "The Multiple Meanings of Mechanisms: A Challenge for the New Mechanist Philosophy" at University of Cambridge, UK. Her PhD thesis "What is Empathy and Is it Valuable?" was done under the supervision of Tim Lewens at University of Cambridge, UK.

Genealogical Approaches and the Origins of Empathy

In my postdoctoral research at the KLI, I aim to undertake two tasks. First, I seek to investigate the method of genealogy broadly considered. Second, I aim to apply a sophisticated evolutionary genealogical approach to the case of empathy. In the first part of my project, I seek to understand how various genealogical approaches—in particular philosophical genealogies as exemplified by Williams (2002) and Craig (1990), traditional evolutionary genealogies, and cultural evolutionary genealogies, as exemplified by the Heyes (2014), Sterelny (2003), and Richerson & Boyd (2005)—relate to one another. How similar are their methodologies? What are the differences between them? What might these various forms of genealogy, which look different on the surface, be able to contribute to one another? Can they be combined fruitfully? In the second part of my project, I aim to provide a sophisticated genealogical approach to empathy that brings together insights from the history of empathy as a human value (philosophical genealogy), cultural evolution, and more traditional biological evolutionary approaches. There is good reason to look to empathy as fertile ground for such an approach because it has important connections with other traits and capacities that have been the subject of cultural evolutionary explorations, including mindreading, psychopathy, and cooperation. I hope that this sophisticated genealogical approach to empathy may help to provide the basis for a mature evolutionary approach to the emotions more broadly.

Daniel BROOKS
(October 2015 – September 2017)

Daniel Brooks holds Bachelor´s degrees in Philosophy and German Studies from the University of Cincinnati and a Master´s degree in Philosophy from Bielefeld University. In 2014, he completed his PhD studies in Bielefeld under his dissertation project "The Concept of Levels

of Organization in Biology." Before his Postdoctoral Fellowship at the KLI, Daniel taught graduate and undergraduate seminars in current topics in the philosophy of science and epistemology at the University of Münster.

The Role of Levels of Organization in Biological Thought

My research project will focus on analyzing the role of "levels of organization" in scientific reasoning about explanation in biology. The concept of "levels" evokes a hierarchical image of the world that is vertically stratified into a graduated continuity: The things found at one horizontal slice of the world somehow "make up" or "are continuous with" things found at another slice, and so on. Yet, despite its ubiquity, "levels" remains a decisively ambiguous concept in biology. The "things" that constitute the horizontal image of the world can vary widely between different contexts. Sometimes they refer to real objects, like part-whole compositional relationships, or they can refer to epistemic units, such as the "level of genetics" or "level of ecology." In my dissertation, I showed that this variability reveals usage of "levels" in science to be governed mostly by its intuitive appeal, whose justification is based on context-dependent criteria of adequacy. Far from useless, however, "levels" instead exemplifies what one philosopher calls "productive ambiguity" of open-ended helping concepts in science. For this reason, philosophical analyses should abandon attempts to unify different uses of "levels" and acknowledge the fragmentary character of the concept.

This research project will expand on this foundation by explicating two distinct roles attributed to the concept of "levels" in different arenas of scientific reasoning concerning explanation. One of these roles is pedagogical, and is often encountered in introductory textbooks to biology, such as the Campbell Biology series, where "levels" is used to introduce the major unifying themes of the field. Another role is organizational, and is encountered in professional research literature of working scientists, in particular review articles and commentaries on the state of research in a certain area of investigation. Here "levels" is often used by scientists as a theoretical

device with which to navigate within complex phenomena distributed across multiple levels, or to coordinate interdisciplinary efforts for investigating such phenomena that cannot be adequately addressed by any one of the involved disciplines alone. Though distinct, these roles complement one another in biological reasoning, albeit in starkly different contexts of scientific practice.

To conduct this analysis I will focus on two case studies from science in which levels are prominently used in both of the roles specified above. The first, macromolecular structure, is treated in a well-defined local manner, focusing on features of (some) macromolecules such as nucleic acid and proteins (but, tellingly, not lipids or sugars). The second, the nervous system, is treated in a more open-ended general manner, owing to the vast complexity of neural phenomena that "levels" is used to investigate.

Barbara FISCHER
(October 2015 – April 2018)

Barbara Fischer studied at University College Cork, Ireland and University of Vienna where she graduated in Biomathematics. She made her PhD in Evolutionary Biology and Biomathematics at the University of Berne, Switzerland. She worked at the University of Helsinki, the University of Berne and at IIASA, Laxenburg/Austria. She was a Postdoctoral Research Associate at the University of Oslo and a Researcher and Lecturer at the University of Vienna.

Evolvability and Integration of the Human Pelvis

Compared to other primates, childbirth is remarkably difficult in humans because the head of a human neonate is large relative to the birth-relevant dimensions of the maternal pelvis. In seems puzzling that females have not evolved wider pelvises despite the high maternal mortality and morbidity risk

connected to childbirth in humans. In the proposed project, I will build a comprehensive novel model of the evolution of the human pelvis. With this project, I will contribute to answering the question why this "obstetric dilemma" still exists in modern humans. Current models explaining the evolution of human pelvic dimensions, or the lack thereof, are based on verbal arguments only. In contrast, I propose to use empirical data on phenotypic variation of pelvic dimensions in human populations (data from populations in North America, Europe, and Southern Africa) as well as mathematical models of evolutionary dynamics (quantitative genetic models) that build on these data to quantitatively assess hypotheses on pelvis evolution. In particular, I will estimate the phenotypic integration and evolvability of different pelvic shape features. In an earlier study, I have shown that evolution has produced covariances between pelvis shape and other body dimensions that contribute to ease childbirth. Based on these results, I will compare the variational properties of the pelvis across sexes and populations. I will devise a quantitative model of the constraints imposed upon the evolution of the human pelvis using the collected empirical data and data from the gynecological literature.

Richard GAWNE
(September 2017 – September 2018)

Richard Gawne is a developmental and evolutionary biologist, currently working as a postdoctoral fellow at the KLI. He holds a PhD in Biology from Duke University. Richard completed his dissertation on the development and evolution of wing patterning in the bella moth Utetheisa ornatrix in 2017, under the supervision of Fred Nijhout. Before coming to the KLI, he was a visiting researcher at the Smithsonian National Museum of Natural History, and a Fulbright fellow at the University of Copenhagen's Center for Social Evolution.

Agriculture as a Co-Evolutionary Process

It can be easy to forget that agriculture isn't a uniquely human accomplishment. Various species of ants, bees, beetles, and termites maintain fungus gardens that are used as a primary food source. This means that in order to develop a truly general hypothesis about the origins or consequences of agriculture, we need to take human and insect systems into account. A review of the published literature from both of these fields reveals that research on the evolution of agricultural arrangements has been conducted almost exclusively from the perspective of the farmers, who are simply assumed to be 'in charge' of things. Accordingly, many have asked how the process of domestication affects the organisms being tended, but few have attempted to determine how partnering with a plant, animal, or fungus affects the evolutionary trajectory of the farmers. The driving rationale of my project is that agriculture should be studied as a co-evolutionary process that elicits significant changes in both farmers and cultivars. It is well known that the brain sizes of human-domesticated animals tend to be reduced, compared to their wild ancestors. Over the course of this project, I will use micro-CT scans to measure the ways in which entering into an agricultural relationship with fungi has impacted the brains of insect farmers. Normalizing for factors such as colony and body size, the prediction is that fungus-farming attine ants will show overall or region-specific reductions in brain size, compared to closely related hunter-gatherer species.

Berta VERD
(May 2016 – August 2017)

Berta Verd holds a Bachelor´s degree in Mathematics from Polytechnic University of Catalonia (UPC), Barcelona and Master´s degrees from Kings College as well as Imperial College, London. She worked on her PhD thesis at the Centre for Genomic Regulation at the Pompeu Fabra University, Barcelona and at the

Wissenschaftskolleg zu Berlin. Berta has recently completed her PhD and is a Postdoctoral Fellow at the KLI.

Evolving Developmental Processes

During insect development, segments either form sequentially (short germ-band) or simultaneously (long germ-band). In depteran insects (flies, midges, and mosquitoes), where the long germ-band mode of segmentation is used, the gap genes are activated by maternal gradients and cross regulate each other to form the first zygotic regulatory layer of the segmentation gene hierarchy. A precise data-driven mathematical model revealed that two distinct dynamical regimes govern anterior and posterior trunk gap gene patterning in *Drosophila melanogaster*. Stationary domain boundaries in the anterior rely on multi-stability whilst the observed anterior shifts of posterior gap gene domains can be explained as an emergent property of an underlying regulatory mechanism implementing a damped oscillator. Major features of both regimes are recovered by a three-gene motif embedded in the gap gene regulatory network. Interestingly, this sub-network, known as the AC/DC motif, can also sustain oscillations. Oscillations are not found in the gap gene system, but are characteristic of short germ-band segmentation, suggesting that both modes share more than previously thought. Studying the evolution of gene regulatory networks can help us understand how oscillations arise or cease, and this will shed some light on how long germ-band segmentation could have repeatedly and independently evolved from the ancestral short germ-band mode. In order to address the evolvability of segment determination dynamics, I propose the following three-part project. The first step will be to perform a comparative analysis of the dynamics of gap gene pattern formation using data-driven models of gap gene regulatroy network in three species of dipteran flies (*Drosophila melanogaster*, *Megaselia abdita*, and *Clogmia albipunctata*) where gap gene expression order is conserved but dynamcis differ. Next, I will characterize intermediate gap gene regulatory networks obtained from *in silico* evolutionary simulations where the gap gene network in the more basal

species *C. albipunctata* has been used as the starting point. These first two parts will help us understand how different expression dynamics arise from different network architectures within the same dynamic mode of segmentation, as well as reveal how these evolutionary changes might be shaped. On a theoretical level, I plant to explore how the evolutionary trajectories between both dynamic modes of segmentation are constrained in parameter space by considering the AC/DC circuit as a basic dynamical module driving segmentation processes.

2.4 Senior Fellowships

Harold DE VLADAR
(October 2017 – October 2018)

Harold de Vladar is a cell biologist, statistical physicist, and artist with a main focus on evolutionary biology. He purposely escapes any disciplinary categorisation and researches on a wide range of subjects spanning genetics, evolution, structural biology, ecology, cancer, synthetic biology, art&science, neuroscience, language, culture and others. Harold has a creative pulse for interdisciplinary methods and is successful in identifying analogies across subjects that give new ways to understand and study evolving systems, such as a statistical-mechanical view of population genetics, an evolutionary description of language and culture, sonification of protein structures, etc. Harold intellectually roots himself with haunting foundational questions of science. He is a researcher in the Hungarian Academy of Sciences and in Parmenides Foundation, near Munich.

Cognitive Cultural Evolution

I propose studying parallels and connection between cultural change and organic evolution using computational and mathematical models. My proposal considers cognitive accounts of concept formation by applying notions of neuroscience and of evolutionary biology to language games. These can be coupled to population dynamics, including spatial mobility and also generational change to study genetic-cultural coevolution.

Willem HORDIJK
(March 2016 – December 2017)

Willem Hordijk is a computer scientist working in the areas of computational biology and bioinformatics. He was a graduate fellow at the Santa Fe Institute for several years, after which he worked on many short-term research and computing projects all over the world. As an independent researcher / consultant he provides computational support to other scientists, while his own research focuses primarily on autocatalytic sets and the origin and organization of life.

Autocatalytic Sets: The Origin and Organization of Life

Life is a self-sustaining and self-regulating chemical reaction network. In other words, a living system continuously regenerates its own components, in such a way that these components maintain and regulate the underlying reaction network that produced them. Autocatalytic sets are a formalization of this notion of life. An autocatalytic set is a reaction network in which each reaction is catalyzed by at least one of the molecules from the set itself, and each molecule can be produced from a suitable food source by using only reactions from the set itself. Autocatalytic sets are believed to have played an important role in the origin and early evolution of life.

Mike Steel and I have developed a formal framework known as RAF theory to detect and analyze autocatalytic sets in general reaction networks. We have shown that autocatalytic sets are highly likely to exist under a wide variety of realistic assumptions in simple computational models of chemical reaction networks, and that these sets usually have a rich hierarchical structure of smaller and smaller autocatalytic subsets, which is an important requirement for their possible evolution. Furthermore, we have shown that the formal framework can be successfully applied to real chemical and biological networks as well, and that autocatalytic sets indeed exist in such real networks.

However, there is still somewhat of a gap between theory and experiments on the emergence and further evolution of autocatalytic sets. In this project, I will continue and expand my research on autocatalytic sets, in particular in collaboration with experimental chemists, in an effort to close this gap.

Stefanie WIDDER
(March 2017 – February 2018)

Stefanie Widder is a computational biologist, a senior fellow at the KLI and affiliated with the Medical University of Vienna. She is working on the systems biology of complex communities, in particular microbial consortia and gene regulatory networks. Her research aims at predictive understanding of complex community functions that find application in human health and related fields.

The Role of the Environment in Shaping Microbial Communities

Microbes are everywhere and make up most of the biomass on earth. They occur in assemblages or microbial communities (MCs) and conduct complex, collective functions that are of highest importance for biogeochemical cycles on earth and human well being alike. E.g., the microbiome in the human

gut can be actively health promoting or causative for chronic diseases or cancer. These emergent community functions are driven by microbial interactions. Despite their relevance, microbial interactions have only recently become subject of scientific research. In the proposed research I will study how divers environments and the predictability of perturbation in these habitats shape microbial interactions and collective functions.

Based on my prior studies, I hypothesize that distinct perturbation levels in natural habitats give rise to different organization of interactions – these types can be detected in sequence data and used for establishing mechanistic understanding of community function. I will use an integrative systems biology approach to study the environmental impact: I will setup a mathematical model that allows the simulation of MCs in predictable and unpredictable environments. I will associate environmental perturbation levels with signatures in community structure and temporal dynamics in the simulated data. Based on the model outcome, I will develop a generic concept of environmental predictability that is applicable to seemingly far-apart cases like the human microbiome or microbiota in soil or wastewater treatment plants. This concept will be used for the analysis of natural MCs from distinct habitats with the aim of predicting community behaviour. The proposed research will have direct applications in medicine, industrial biotech, and global climate regulation.

2.5 Hans Przibram Fellowship

James DiFRISCO
(October 2017 – September 2018)

James DiFrisco received his PhD in Philosophy from University of Leuven, Belgium, with a dissertation entitled "Process and Levels of Organization: A Dynamic Ontology for the Life Sciences." He was a Postdoctoral

Fellow at the KLI and was recently awared a Hans Przibram Fellowship to continue his work at the KLI. His research focuses on problems related to biological organization, functions, individuality, and levels, as well as on a variety of themes in naturalistic metaphysics including physicalism and the relations between scientific domains.

Hierarchy and Individuality

According to ordinary intuition, living individuals and organisms are the same thing. Developments in the life sciences, however, have indicated that familiar organisms are just one case of individuality among others, including genes, cells, colonies, groups, species, and even ecosystems. It has therefore become a problem to explain what it is, in general, that makes something a biological individual. My project takes its point of departure from the insufficiency of evolutionary explanations currently on offer, in which being an individual roughly means being a unit of selection. Instead of opposing this by recourse to more physiological explanations of individuality, however, I suggest it will be more illuminating to integrate both within a more general hierarchical framework. I propose to do this by introducing into the discussion a dynamical or process-based view of both individuation and hierarchical organization. A dynamical perspective ensures that biological individuation is explained as an ongoing, evolving process. A hierarchical perspective is necessary for accommodating the fact there are different dynamics at different levels and scales that are causally responsible for individuating biological systems.

Carrying out this project will involve developing an alternative to the dominant approaches to biological hierarchy theory that relies on dynamical parameters and pervasive scalar properties of the living world. I also connect the issues of biological individuality and hierarchy to wider concerns about the explanatory power of natural selection, problems with biological functionalism, and the relationships between biology and the other natural sciences.

2.6 Visiting Scientists

Ehab ABOUHEIF
(November 2017 – July 2018)

Ehab Abouheif studied biology at Concordia University, Montreal (BSc, 1993), at SUNY, Stony Brook, NY, and at Duke University, Durham, NC. He was a post-doc in the Department of Organismal Biology and Anatomy at the University of Chicago (2002-03) and in the Department of Integrative Biology, Howard Hughes Medical Institute, University of California, Berkeley (2003-04); Nipam Patel was his supervisor both in Chicago and Berkeley. From 2004 to 2010 he was Assistant Professor at McGill University, Montreal, Quebec, and subsequently Associate Professor in the Department of Biology at McGill University, where he held the Canada Research Chair in Evolutionary Developmental Biology. He stayed at the KLI in 2011 with a visiting fellowship. He is now a Full Professor at McGill University and has recently been awared a Guggenheim Fellowship and a KLI Visiting Fellowship for his stay at the KLI.

The Theory of Mesoevolution

As a Visiting Fellow at the KLI, my main goal will begin, and make substantial progress, writing a monograph that expands and formalizes my "Theory of Mesoevolution" (Abouheif 2008. Parallelism as the pattern and process of mesoevolution. Evolution & Development). This theory, which promises to potentially connect the domains of micro- and macroevolution, will tackle one of the largest and unresolved questions in evolutionary biology. It will attempt to make this connection through the concept of parallelism, which is often defined as the independent evolution of traits that share a common developmental basis. Parallel evolution is widespread and represents a "gray zone" between homologous and convergent evolving traits. I will argue in my monograph that this gray zone is the key for linking micro- and macroevolution.

Jan BAEDKE
(June – July 2017)

Jan Baedke is an Assistant Professor at the Department of Philosophy I, Ruhr University Bochum. His research focuses on the history and philosophy of the life sciences (especially biology), and philosophical anthropology. He received his PhD in 2014. His thesis focused on conceptual issues related to causal explanation in epigenetics. Since then he has been a Visiting Scholar at the Centre for the Study of Life Sciences (Egenis, University of Exeter), the City University of New York (CUNY), and the National Autonomous University of Mexico (UNAM). His current German Research Foundation (DFG) funded project is entitled 'Extended Synthesis and Scientific Explanation: Challenges of Theoretical Expansion in Modern Biology.' It investigates the conceptual and methodological challenges going along with the current introduction of novel explanatory approaches in evolutionary theory by more developmentally oriented accounts, such as evo-devo, epigenetics, and niche construction theory.

'Extended Synthesis' and Scientific Explanation: Challenges of Theoretical Expansion in Modern Biology

The explanatory paradigm of biology – the population-genetic, neo-Darwinian Modern Synthesis – which has been established in the middle of the 20th century, has recently been plunged into a crisis. Currently a growing number of biologists call for an expansion of evolutionary theory by a more developmentally orientated account, a so-called 'Extended Synthesis.' The novelty of this theory is widely discussed by biologists, historians of science as well as in public. Despite this broad interest in the current dynamics of modern biology, philosophers of science have yet neglected most widely investigating the challenges and problems going along with such a theoretical expansion and integration of conventional and progressive explanatory approaches. Meeting these challenges is the central aim of the proposed research

project. Therefore, first, the conceptual foundations and the standards of causal and mechanistic explanation are systematically assessed in those novel fields that are said to drive the current revolutionary change in evolutionary theory, i.e. evolutionary developmental biology (evo-devo), epigenetics, and niche construction theory. Based on this investigation, second, a number of previously neglected inter- and intradisciplinary conflicts are identified, which currently counteract theoretical integration. Subsequently, third, it is analyzed due to which criteria and given which explanatory contexts the more developmentally orientated Extended Synthesis explains better than the neo-Darwinian Modern Synthesis. Thus, this biophilosophical project not only contributes to a better understanding of the current theoretical change in biology. Moreover, it offers solutions that meet the challenges of theoretical integration and explanatory pluralism. In addition, it gives a new impetus to specifying the anthropological relevance of the current expansion of evolutionary theory by explanations that focus on ontogenetic processes and organism-environment interactions.

Thomas CHARTIER
(May – June 2017)

Thomas Chartier received an engineering degree in 2011 from the Ecole Polytechnique in Paris, with major in Mathematics and Physics. Interested in life sciences from a physicist's perspective, he followed an interdisciplinary Masters programme at Paris Diderot University and became familiar with various animal models and research topics: biophysics in the nematode Caenorhabditis, neurogenetics in the fruitfly Drosophila, cognitive psychology in the Guinea baboon. He was introduced to philosophy and history of biology, while working on the notion of cell type and tissue classification with the philosopher Jean-Jacques Kupiec at ENS Paris. He is currently a PhD student with Detlev Arendt at EMBL

Heidelberg. Using a recently established animal model, the marine worm Platynereis dumerilii, he seeks to better understand the evolutionary origin of a fundamental animal cognitive ability: associative learning.

Evolutionary Origin of Associative Learning

Associative learning seems to be a general mechanism in animal cognition, reported in many phyla in its most elementary forms, and constitutes an excellent theoretical framework to understand how complex representations of the environment can be acquired, stored, and accessed. However, it is unclear how and when this cognitive ability would have appeared, and if it might have had a single origin, potentially specific to bilaterian animals. No updated view is available on the evolutionary importance and possible origin of this behavioral innovation, despite an old, but rich literature on invertebrate learning, detailed knowledge of neurobiological mechanisms in some model species, and new insights on animal phylogeny. My aim is to provide such a statement, by integrating information from fields like comparative psychology, comparative neurobiology, phylogenetics, and evolutionary developmental biology; this would constitute the theoretical chapter of my PhD thesis. The rapid emergence of new animal models make it possible today to test evolutionary scenarios on behavior, consequently a global theoretical frame on associative learning in the animal kingdom could be of great value to help understanding the origin, thus the fundaments, of animal cognition.

Lynn Chien-Hui CHIU
(May 2017)

Lynn Chiu holds a PhD from the University of Missouri in Philosophy of Biology. 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. She was a Writing-Up Fellow at the KLI in late 2013 and a visiting PhD

student at University of Vienna, in 2015. She is now a Postdoc at the University of Bordeaux / CNRS, in Thomas Pradeu´s group.

Holobiont and Eco-Immunity

Advances in microbiome research allow us to question the nature of „us", the microbiota + host, as biological individuals („holobionts"). One aspect of the holobiont is the symbiotic construction of host & host-microbial immunity. Findings in this area show that the immune system must be considered in its internalized and external ecological context, not just to assess its evolutionary context and trade-offs, but to fully understand the immune system's symbiotic development and activities.

My research under Thomas Pradeu's ERC grant examines how host-microbiota eco-immunity challenges an internalist paradigm in immunology that comes from two sources: genetic determinism and the self/nonself model of immunity. We argue that holobiont immunity is co-constructed by host and microbiota and transmitted to the next generation.

At the University of Bordeaux, I am embedded within the Immuno ConcEpT Lab (Immunology, from Concepts and Experiments to Translation). The empirical aspect of my work is conducted in collaboration with two scientific groups, a microbiota group (which includes members of the rheumatology unit of the teaching hospital of the University of Bordeaux) and an innate lymphocyte cell group focused on the diverse roles of immunity.

Markus ERONEN
(March 2017)

Markus Eronen is a postdoctoral fellow of the Research Foundation Flanders (FWO) at KU Leuven, and a visiting scholar at the University of Groningen. He studied philosophy and cognitive science at the University of Helsinki, and defended his PhD thesis in 2010 at the Institute of

Cognitive Science in Osnabrück. He has been a postdoc at the Ruhr University Bochum and a visiting fellow at the University of Cincinnati and UC Davis. His current work aims at applying insights and methods of philosophy of science to problems that arise in scientific practice in various fields. His research topics include causal inference and discovery in psychology, scientific realism in the special sciences, and the nature of hierarchical organization in biology.

New Perspectives on Levels of Organization in Biology

The idea of levels of organization is ubiquitous in biology, but has proven to be difficult to analyze or formulate in detail. The proposed visit to the KLI in March 2017 is a part of a larger project that aims at developing a deflationary and heuristic theory of levels of organization. The guiding idea of this project is that the main role of the levels concept is to provide guidance and tools for scientific research, and not to delineate ontological categories in nature. The aim of the visit is (1) to present this account of levels to the interdisciplinary audience at KLI, thus subjecting it to discussion and critical feedback, and (2) to work on two papers related to this project with Daniel Brooks, who is currently a fellow at the KLI. The interdisciplinary environment of KLI provides a unique opportunity to discuss and develop my work, helping to make it accessible and relevant for both scientists and philosophers.

Brian G. HENNING
(May – August 2017)

Brian G. Henning is Professor of Philosophy and Environmental Studies at Gonzaga University in Spokane, Washington (USA) where he serves as the Faculty Fellow for Sustainability. He is the Founding Executive Editor of the Edinburgh Critical Edition of the Complete Works

of Alfred North Whitehead. His research includes more than thirty articles and seven books and edited volumes, including Beyond Metaphysics? Explorations in Alfred North Whitehead's Late Thought, Beyond Mechanism: Putting Life Back Into Biology, and Thinking with Whitehead and American Pragmatists. His 2005 book, The Ethics of Creativity, won the Findlay Book Prize from the Metaphysical Society of America and was named a "Top Ten Pick" by Foreword magazine. He is currently working on a book on environmental metaphysics.

Environmental Metaphysics

I am currently working on a book-length manuscript that defends an "environmental metaphysics" based on Alfred North Whitehead's (1861-1947) "philosophy of organism." Extending my work in, The Ethics of Creativity: Beauty, Morality, and Nature in a Processive Cosmos, the basic premise of this new book is that the last four decades of debate in environmental ethics over the scope and nature of intrinsic value failed to achieve any significant progress because most participants refused to examine the metaphysical assumptions on which their axiology is based. Thus, I defend both the need for and then a specific version of environmental metaphysics that serves as the basis for a compelling environmental ethics. This work is novel in that the field of environmental metaphysics does not yet exist.

While at KLI in the summer of 2017, I propose to work on one chapter of this larger work. Specifically, I will examine the scientific and philosophical research concerning planetary-level homeostasis, also known as the Gaia hypothesis. This relates to and extends my earlier work examining the ontology of homeostasis in social insects (see „Of Termites and Men: On the Ontology of Collective Individuals"). My claim is (1) that Whitehead's philosophy of organism is able to account for the forms of ontological individuality implied by planetary-level homeostasis in a way that modern and ancient substance-based metaphysics cannot and (2) that such an account leads to a more adequate environmental metaphysics and ethics.

Jan-Hendrik HOFMEYR
(May 2017)

Jan-Hendrik (Jannie) Hofmeyr: Distinguished Professor of Biocomplexity and Biochemistry and Co-Director of the Centre for Complex Systems in Transition at the University of Stellenbosch. He has been a member of the Biochemistry Department since 1975. His research of the past 30 years has been in the field of computational systems biology where his main focus has been the understanding of regulatory design of metabolism. He obtained his Ph.D. in 1986 at the University of Stellenbosch after collaborating with Henrik Kacser and the enzymologist Athel Cornish-Bowden. In the late 90s Jannie and his colleagues Jacky Snoep and Johann Rohwer formed the Triple-J Group for Molecular Cell Physiology in the Department of Biochemistry; this research group studies the control and regulation of cellular processes using theoretical, computer modelling and experimental approaches. He has made numerous fundamental contributions to the development of metabolic control analysis and computational systems biology, and with Athel Cornish-Bowden developed both co-response analysis and supply-demand analysis as a basis for understanding metabolic regulation.

Cellular Self-Fabrication

The fundamental property that distinguishes the living from the non-living is the ability to fabricate itself, i.e., to autonomously synthesise all of its molecular machinery from nutrients obtained from its environment. This is possible because organisms are, in Robert Rosen's words, closed to efficient causation, or, in Maturana and Varela's, autopoietic. This property, which holds for both the organism and its individual cells, is also the most basic expression of biological anticipation in that organisms and their cells take antecedent action, continuously fabricating themselves in anticipation of a future non-functional and deleterious internal state.

Rosen's formalisation of the four Aristotelean causes

(material, efficient, formal, final) allowed him to construct a graph-theoretical depiction of a functional component of any system that shows how efficient and formal cause act on material cause (input) to give final cause (output). The functional organisation of any system can be visualised as a graph that shows how the components of a system are connected. For the living cell to be closed to efficient causation its fabrication processes must be arranged in a so-called hierarchical cycle; to form a hierarchical cycle all the efficient causes if the system must be internal edges in the graph. The quintessential example is Rosen's metabolism-repair system, abbreviated as (M,R)-system. However, the mappings in Rosen's diagram of an (M,R)-system, especially the so-called replication map, have been notoriously problematic to realise in terms of real biochemical processes. From a category-theoretical point of view the replication map is a perfectly valid way of closing the system to efficient cause, but neither Rosen nor anybody else has been able to find a biological realisation of it.

I approach the problem of realising the hierarchical cycle in the cell from a biochemical point of view by identifying the classes of efficient biochemical causes in the cell and showing how they are organised in a hierarchical cycle. Broadly speaking, the three classes of efficient causes are the catalysts that drive covalent metabolic chemistry and produce (as yet non-functional) polypeptides and polynucleotides, the intracellular milieu that drives the supramolecular processes of chaperone-assisted folding and self-assembly of polypeptides and nucleic acids into functional molecular machinery (catalysts and transporters), and the membrane transporters that maintain the intracellular milieu, in particular its electrolyte composition. The key to my analysis is the realisation the matrix in which the functional components of a system are embedded (what I call the intracellular milieu) is itself a functional component of the system, an efficient cause. I use Rosen's graph-theoretical formalism to construct an alternative diagram that shows how these three classes of efficient cause are related to form a hierarchical cycle. What is particularly interesting is that my analysis shows how Von Neumann's universal constructor organisation is embedded in the diagram, albeit in a new guise, and how it merges with

Rosen's metabolism and repair components. It also makes explicit Howard Pattee's symbol-matter system in the cell and Marcello Barbieri's genotype-ribotype-phenotype ontology.

Nick MONK
(March – September 2017)

After reading Natural Sciences and Mathematics as an undergraduate, Nick Monk studied for a PhD at Birkbeck College, London with Basil Hiley. At Birkbeck, he contributed to the development of a fully algebraic formalism for quantum mechanics that provides a mathematical realisation of a process-based ontology. Since obtaining his PhD, his research has focused on mathematical modelling of biological phenomena, predominantly in the context of cell and developmental biology. A central concern in this work has been the importance of dynamics in living systems, and a current focus is on the ways in which the structures of dynamical systems can be used to provide a more process-based approach to biology. He has held positions in Oxford, Nottingham and Sheffield, and is currently a professor in the School of Mathematics and Statistics at the University of Sheffield, and a Visiting Fellow at the KLI.

Understanding Evolution Through Dynamical Systems

"Understanding" the behaviour of a system depends on projection from the space of manifest phenomena to a distinct conceptual space. These projections can take many forms, corresponding to different types of understanding, such as analogy, metaphor, and mechanism. This project explores how the abstract mathematical spaces resulting from dynamical systems models provide new sets of explanatory structures, distinct to those provided by specifying the components of the system. In dynamical systems models, a given system composition (the components, and their modes of interaction) corresponds to an abstract configuration space, or phase

space, each point of which corresponds to a possible state of the system. I use specific models of developmental and physiological processes to explore how system-level behavior (and the propensities for significant changes in behavior) can be understood in terms of the natural descriptors of configuration space. I will use the results of these mathematical studies as concrete examples of how a process-based understanding can give novel mechanistic insight into the emergence of developmental and physiological behaviors, and their evolution.

Matthew SLATER
(April – May 2017)

Matthew H. Slater is an Associate Professor of Philosophy at Bucknell University in the USA. He is the author of "Are Species Real?" (Palgrave, 2013), has co-edited a number of volumes on metaphysics and the philosophy of science (including, from MIT Press, "Carving Nature at its Joints" (2011), "The Environment: Science and Ethics" (2012), and from Oxford University Press "Metaphysics and the Philosophy of Science"). He has written widely on metaphysics, philosophy of biology, and social epistemology. His recent essay, "Natural Kindness" won the 2015 Karl Popper Prize from the British Society for the Philosophy of Science. He is currently working on two book projects: one focusing on biological classification at various levels of generality and another, co-authored with Matthew Barker, on the role that norms play in scientific classification in general.

Biological Kinds in Scientific Practice

Extant accounts of natural kinds have notoriously struggled to accommodate the vagaries of classificatory practice in the biological sciences. This most evident for the classification of species — where the thesis that species are natural kinds has fallen substantially out of favor — but problematic as well for less charismatic examples such as our classification of cells,

tissues, diseases, ecosystems, and so on. Many philosophers of biology have regarded Boyd's "Homeostatic Property Cluster" (HPC) account of natural kinds to feature the right balance of flexibility and specificity. I have argued, however, that while an improvement on essentialist approaches, the HPC account faces conceptual problems and difficulties of application to certain cases (Slater 2015). In that paper, I proposed an alternative account of natural kinds that showed promise in addressing these problems. I conceive of natural kinds "adjectivally" — that is, rather than seeing natural kinds as an ontological category, as a left-alone feature of reality, I argue that it is more fruitful to see "natural kindness" as a status that a category can possess in virtue of its aptness to contribute to our explanatory and inferential practices. This status is domain- and contextrelative, however, introducing a dose of pragmatism into an account of biological kinds. I propose to use my time at KLI to work on one or two of my case studies and address the tension between realism and pragmatism in my account at a conceptual level.

2.7 Scientist with Own Funding

Mihaela PAVLICEV
(March 2017)

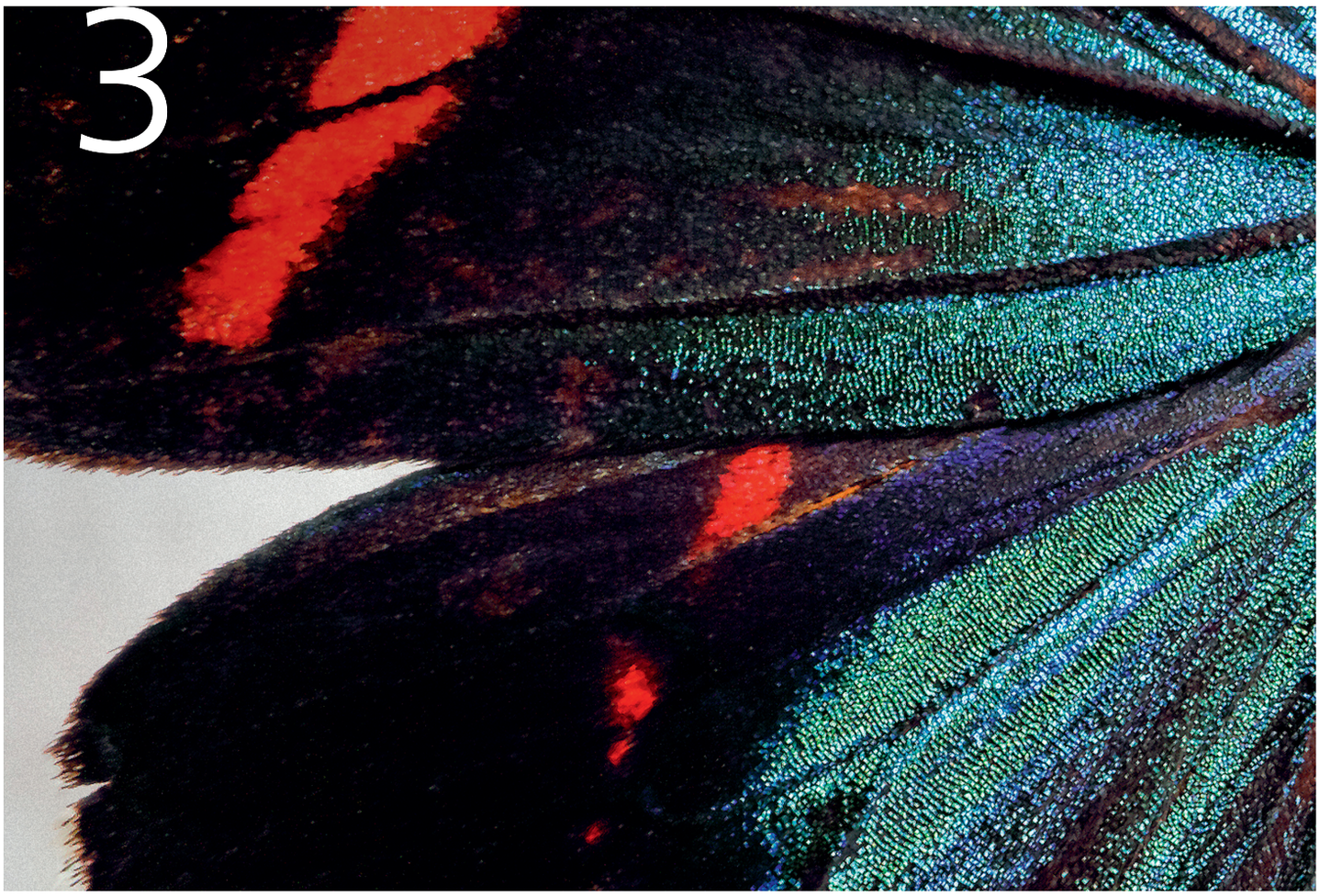
Mihaela Pavlicev is an evolutionary biologist with a wide range of interests. After finishing her PhD in Ecology in Vienna, 2003, she joined the Natural History Museum in Vienna to work on molecular phylogenetics of reptiles (with E. Haring, W. Mayer). This was followed by two consecutive postdoctoral appointments in evolutionary quantitative genetics, in St. Louis (with J. Cheverud) and in Oslo (with T. Hansen). Mihaela subsequently returned to Vienna as a postdoctoral fellow at KLI and lecturer at the University of Vienna, before taking a faculty position at the University of Cincinnati Medical School/ Cincinnati

Children`s Hospital in Ohio in 2013.
Mihaela`s work has been focused around the influence of the structure of genotype-phenotype map on evolutionary response to selection, as well as the evolution of this map. Two aspects of the genotype-phenotype map, which is essentially an abstraction of developmental, physiological genetic structure, have been of particular interest: the evolution of gene effects and the impact of pleiotropic genes affecting multiple traits.
More recently, Mihaela started exploring how evolutionary approaches to studying variation of traits, both short- and long term, can be used to understand specific trait states, namely disease. Recent work includes theoretical and experimental work focusing on the evolution of mammalian pregnancy and its relevance for human medicine.

Evolutionary Origin, Modification, Effect and Importance - the Riddle of Female Orgasm

The existence of human female orgasm has posed a much-discussed challenge to evolutionary biologists and broader. What is its role? The evidence for any direct reproductive effect is lacking: women readily conceive without ever experiencing orgasm, and penetrative sex without additional clitoral stimulation is not the primary trigger of orgasm for females. To address the question, we focused on physiological proxy- the neuroendocrine hormonal surge that accompanies human female orgasm. Remarkably, this surge is similar to the neuroendocrine reflex which triggers ovulation in copulation-induced mammals, such as rabbits, ferrets or cats. This suggests that human female orgasm may be a vestige of an evolutionarily older reflex inducing ovulation, which lost its role with the evolution of endogenously regulated ovulatory cycle. Apart from endocrine similarities, two types of evidence support this idea. The first is that copulation-induced ovulation evolutionarily precedes spontaneous ovulation. The second is that female genital anatomy has changed to remove clitoris from copulatory canal concurrent with the evolution of spontaneous ovulation.

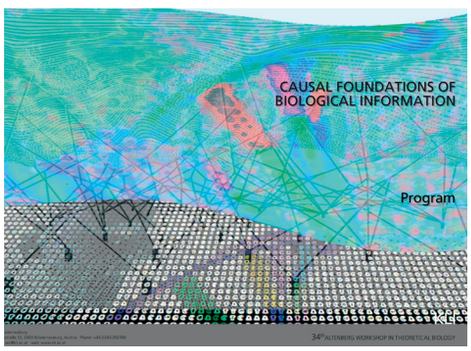
Meetings and Lectures



The KLI supports international workshops, symposia, and individual talks that are organized 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."



34th Altenberg Workshop in Theoretical Biology 6 – 9 July 2017

Causal Foundations of Biological Information
KLI Klosterneuburg

Organization: Karola Stotz and Paul E. Griffiths

Topic and Aims

The source of order in living systems has been the key question at the boundary of biology and philosophy since the eighteenth century. Today it is widely believed that living systems differ from non-living because they are driven by information, much of which has accumulated during evolution, and much of which is genetically transmitted. But there is at present no specifically biological measure of information that can underpin this vision. This project aimed to fill that gap by grounding the idea of biological information in contemporary philosophical work on the nature of causation.

The project set out to develop a measure of biological information inspired by the early theoretical insights of the co-discoverer of the structure of DNA, Francis Crick, but general enough to capture information-processing in gene regulatory networks, epigenetic information, and the emergence of new information in self-organising processes. The workshop represents a central first step in evaluating how well these objectives have been met by presenting the main results produced by the project investigators to a selected group of philosophers of biology and theoretical biologists.

This workshop comes at the end of the three-year research project "Causal Foundations of Biological Information," funded by the Templeton World Charity Foundation.

Program

ALYSSA ADAMS
Arizona State University, Tempe
Mechanisms for Open-Ended Evolution in Dynamical Systems

BRETT CALCOTT
University of Auckland
Information and Evolvability in Gene Regulatory Networks

BERNAT COROMINAS-MURTRA
Medical University of Vienna
Information in Evolving Systems: From Shannon Framework and Beyond

WALTER FONTANA
Harvard University / Medical School, Cambridge, MA
Causality in (Models of) Molecular Signaling

PAUL E. GRIFFITHS
University of Sydney
Information in Biological Theory and Philosophy of Biology

RUSSELL GRAY
Max Planck Institute for the Science of Human History, Jena
Macro Matters: Cultural Macroevolution and the Prospects for an Evolutionary Science of Human History

EVA JABLONKA
Tel Aviv University
Functional Information and Sample Selection in Learning

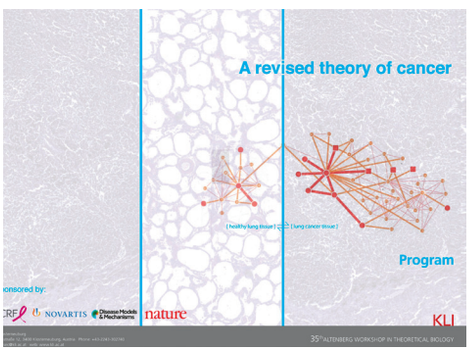
JOHANNES JAEGER
Complexity Science Hub, Vienna
Positional Information: On the Uses and Abuses of the Term in Developmental Biology

ARNAUD POCHEVILLE
University of Sydney
Crick Information: Giving Substance to Biological Information

SONJA J. PROHASKA
University of Leipzig
Computational Aspects of Epigenetic Gene Regulation

KAROLA STOTZ
Macquarie University, North Ryde
When is a Biological Cause a Source of Information?

EÖRS SZATZMÁRY
Eötvös Loránd University, Budapest
Efficient Causes, Organization, Gratuity, and Biosemiotics



35th Altenberg Workshop in Theoretical Biology 10 – 12 November 2017

A Revised Theory of Cancer

KLI Klosterneuburg

Organization: Mina J. Bissell, I. Ernberg, and B. Strauss

Topic and Aims

Ever increasing amounts of DNA sequence-based "cancer mutation" data have added much to our understanding of the human genome over the past decade. However, whereas detailed sequencing has helped delineate new pathways and has led to some progress in specific cancer types, this has not delivered a real breakthrough in our understanding of cancer. We believe it is time to re-assess some of the scientific concepts that underpin current mainstream cancer research, such as the "Somatic Mutation Theory" of cancer in light of solid experimental data and alternative theoretical concepts that have accumulated over several decades in different areas of cell and cancer biology as well as big data analysis methodologies. The workshop is anticipated to start the process of integrating these insights into a new framework of "a revised theory of cancer."

The Workshop is dedicated to the memory of Susan Lindquist (Whitehead Institute, MIT) and George Klein (Karolinska Institute, Sweden), two brilliant and amazingly successful scientists who have embraced 'a revised theory of cancer' late in their scientific careers.

Program

MARTA BERTOLASO
University of Rome
A Disease of Biological History: A Dynamic and Relational View of Cancer

MINA J. BISSELL
Lawrence Berkeley National Laboratory, Berkeley, CA
Why Don´t We Get More Cancer?

CÉDERIC BLANPAIN
Université Libre de Bruxelles
Cancer Cell Origin and Tumor Heterogeneity

PETER CSERMELY
Semmelweis University, Budapest
Adaptation of Cancer Cell Networks

PAUL C.W. DAVIES
Arizona State University, Tempe
Cancer as a Reversion to an Ancestral Phenotype

INGEMAR ERNBERG
Karolinska Institute, Stockholm
Intercellular Cancer Cell Heterogeneity Beyond Genes and Epigenetics

CYRUS M. GHAJAR
Fred Hutchinson Cancer Research Center, Seattle, WA
Targeting Dormant Tumor Cells for Metastasis Prevention

VERA GORBUNOVA
University of Rochester, New York
Lessons from Cancer-Resistant Species of Mammals

EDOUARDO HANNEZO
Institute of Science and Technology Austria, Klosterneuburg
Defining the Clonal Dynamics of Skin Tumor Initiation

SUI HUANG
Institute for Systems Biology, Seattle, WA
Towards a Unifying Theory of Cancer: On the Intrinsic Inevitability of Cancer

GIORGIO INGHIRAMI
Weill Cornell Medicine, New York
The Maladapted Vascular Niche Initiates Tumor Stem Cells, and Fosters Metastasis and Chemoresistance by Supplying Aberrant Angiocrine Factors

BARBARA MARTE
Nature, London

JÖRG MENCHE
CeMM Research Center for Molecular Medicine of the Austrian Academy of Science, Vienna
Network Approaches in Medicine: From Protein-Protein to Drug-Drug Interactions

TIM NEWMAN
University of Dundee
Simple Models of Rare Events Giving Insights into Cancer Initiation and Metastasis

LARRY NORTON
Memorial Sloan Kettering Cancer Center, New York
Evolving Concepts Concerning the Nature of Neoplasia

JACQUES POUYSSEGUR
University of Nice–Sophia Antipolis–CNRS-Inserm
Targeting Acidic, Nutritional and Oxidative Stresses in Cancer

JACCO VAN RHEENEN
Hubrecht Institute and UMC Utrecht
Intravital Imaging of Cancer Cells and Their Microenvironment

KAHN RHRISSORRAKRAI
IBM Research, New York
An -Omic Centric Approach to Advancing Precision Oncology

TOBIAS SJÖBLOM
Uppsala University
How Should We Go About to Discover Truly Useful Cancer Biomarkers?

BERNHARD STRAUSS
The Gurdon Institute, Cambridge
Why We Need a Revised Theory of Cancer

EMMY VERSCHUREN
University of Helsinki
Histophatology-Specific Phenotypes as Disease Vulnerabilities

VALERIE WEAVER
University of California, San Francisco
Interplay Between Extrinsic and Intrinsic Force Regulates Cancer Progression and Treatment Response

3.2 KLI Focus Group

The KLI Focus Group is a newly developed format that gathers leading experts of an interdisciplinary field with the aim to develop ideas on a particular subject and generate suggestions for action. The invitees come from different scientific backgrounds and strive to develop specific, practical goals within the designated period of one to two weeks.

1st Focus Group
24 – 29 September 2017

Synthesizing (a Kind of) Life
KLI Klosterneuburg

Organization: Wim Hordijk

Topic and Aims

During the last week of September 2017, the KLI's first ever focus group meeting took place. The meeting was organized by KLI senior fellow Wim Hordijk, and the participants included Stuart Kauffman, Eors Szathmary, Niles Lehman, Sijbren Otto, Christoph Flamm, and Marco Villani. The main purpose of the meeting was to produce a first draft for a research proposal on the origin of life based on the notions of autocatalytic sets and protocells. The participants will continue their joint efforts over the next several months to finalize the proposal, building on what was discussed and produced during their meeting at the KLI.

CHRISTOPH FLAMM, University of Vienna
WIM HORDIJK, KLI, Klosterneuburg
STUART KAUFFMAN, Institute for Systems Biology, Seattle
NILES LEHMAN, Portland State University, OR
EÖRS SZATHMÁRY, Parmenides Foundation, Pullach
MARCO VILLANI, University of Modena and Reggio Emilia

3.3 Summer School

5th European Summer School in Evolutionary Developmental Biology
18 – 21 September 2017

Process Thinking for Evo-Devo
Istituto Veneto di Scienze, Lettere ed Arti, Venice

Organizers: Sandro Minelli and Gerd Müller
School Director: Johannes Jäger

Topic and Aims

Evolution can be seen as an immense, nested, multi-level diversifying process, working across a wide range of temporal and spatial scales. This process explores the incomprehensibly large space of possibilities of the universe. Everything in biology is a dynamic process, from gene regulation to cellular behaviour to development to the life cycle to ecological and population-level dynamics to speciation and extinction to large-scale phylogenies and body plan evolution.

For this reason, approaches based on process philosophy have great explanatory power and potential in the field of evolutionary developmental biology (evo-devo). Yet they are woefully neglected! Our discipline has moved from single-gene explanations for developmental evolution to more systems-level explanations in terms of gene regulatory networks and their modular structure. However, these concepts still do not provide adequate explanations since they are static. They do not properly explain how phenotypes originate and evolve. They are a starting point rather than the end of investigations in evo-devo. We need alternative approaches, based on a processual view of reality if we are to transcend this fundamental limitation.

The overall aim of the course is to introduce process-based research approaches and conceptual frameworks to a broad range of experimentalists, theoreticians, and philosophers interested in the problem of (developmental) evolution. We discuss relevant concepts from process philosophy and dynamical systems theory through a number of foundational theoretical lectures. These will be complemented by specific examples of how process thinking can be and is already being used to get specific insights and new explanations for evolutionary and

developmental dynamics. Morning lectures are followed by interactive discussions and reading clubs in small groups in the afternoons. Participants will also be able to present their own work to the teachers and the other students at a poster session on the first evening.

No previous technical skills in mathematics or programming are required to participate. Neither is any previous training in the philosophy of science. At least some basic knowledge of the foundations of evo-devo would do no harm. But the most important things to bring are an interest in deep conceptual questions in the field of evo-devo, and a willingness to discuss these questions with an open and critical mind!

Teaching panel

GRAHAM BUDD
University of Uppsala

JAMES DiFRISCO
KLI, Klosterneuburg

SCOTT GILBERT
Swarthmore College, Swarthmore, PA

JOHANNES JAEGER
Klosterneuburg

RONALD JENNER
Natural History Museum, London

STUART KAUFFMAN
Institute for Systems Biology, Seattle, WA

NICK MONK
University of Sheffield

BERTA VERD
KLI, Klosterneuburg

3.4 Collaborative Workshop

Workshop
"Cause and Process in Evolution"
11 – 14 May 2017

KLI Klosterneuburg

Organized by: Kevin N. Laland & Tobias Uller

Topic and Aims

The aim of this workshop is to initiate close interaction and exchange between philosophers of science and biologists, both within the research programme and outside it, to reflect on the nature of causation in biological evolution. The EES has a different perspective on causation in evolution, and ascribes a greater range of processes evolutionary significance, than traditional perspectives. The workshop will set out to scrutinize these claims, with both philosophers (acting as independent arbiters) and non-project members (including non-sympathizers) present to ensure good debate.

The nature of these differences will be discussed and their implications for the structure of evolutionary theory will be drawn up. In addition to leading to a key synthetic publication, the discussion will effectively provide a guide for continued exchange between conceptual analysis and empirical and theoretical projects within the wider research programme, such that each can benefit from the other, in terms of interpretation and communication of results.

Speakers

TOBIAS ULLER
Lund University

ARMIN MOCZEK
Indiana University, Bloomington, IN

SUSAN FOSTER
Clark University, Worcester, MA

SONIA SULTAN
Wesleyan University, Middletown, CT

KEVIN LALAND
University of St. Andrews

RENEE DUCKWORTH
University of Arizona, Tucson

HEIKKI HELANTERÄ
University of Helsinki

PAUL BRAKEFIELD
University of Cambridge

ARLIN STOLTZFUS
University of Maryland, Rockville, MD

RICHARD WATSON
University of South Hampton

LYNN CHIU
CNRS & University of Bordeaux

JOHANNES JAEGER
Klosterneuburg

SAMIR OKASHA
University of Bristol

JUN OTSUKA
Kobe University, Shindai

KAROLA STOTZ
Macquarie University, North Ryde

TIM LEWENS
University of Cambridge

DENIS WALSH
University of Toronto

ARNAUD POCHEVILLE
University of Sydney

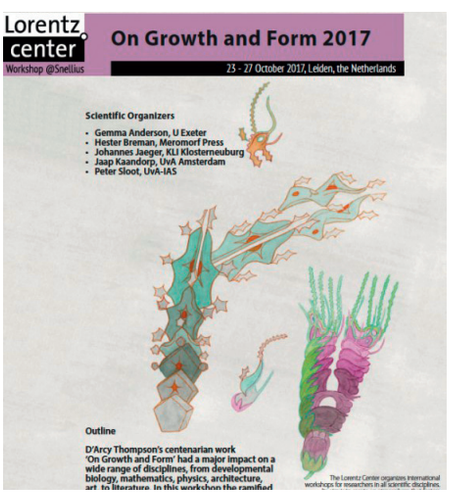
MASSIMO PIGLIUCCI
City University of New York

GERD MÜLLER
University of Vienna & KLI, Klosterneuburg

3.5 Co-Funded Events

Workshop
WiKo / College for Life Sciences & KLI
22 – 25 January 2017
Wissenschaftskolleg zu Berlin

Organized by: Ulrike Pannasch, WiKo

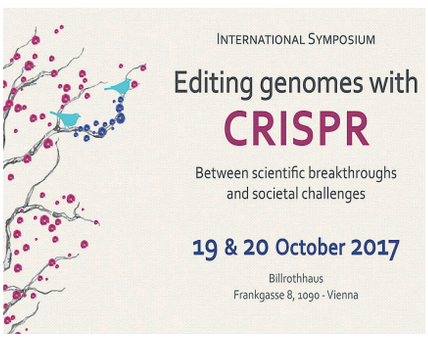


Workshop
On Growth and Form
23 – 27 October 2017
Lorentz Center@Snellius

Organized by: Gemma Anderson (Univ. Exeter) • Hester Breman (Meromorf Press) • Johannes Jaeger (Klosterneuburg) • Jaap Kaandorp (UvA Amsterdam) • Peter Sloot (UvA-IAS)

Topic

D'Arcy Thompson's centenarian work 'On Growth and Form' had a major impact on a wide range of disciplines, from developmental biology, mathematics, physics, architecture, art, to literature. In this workshop the ramified and complex legacy is re-evaluated by participants from all influenced fields.



Symposium
Editing Genomes with CRISPR: Between Scientific Breakthroughs and Societal Challenges
19 – 20 October 2017

Billrothhaus der Gesellschaft der Ärzte in Wien

Organized by University of Vienna

Topic

An extremely important scientific revolution is taking place with the discovery and development of a gene-editing technology termed CRISPR-Cas9. With this tool, the genomes of various organisms can now be edited with unprecedented specificity and simplicity of use. This opens many possibilities for basic research. It also enables the development of numerous applications in biomedicine, agriculture, in addition to offering novel ways of tackling environmental challenges. The potential implications for the further evolution of species, including our own, as well as for our relationship to nature are profound. Thus, the ongoing scientific revolution opens up questions of safety and ethical responsibility, invokes issues of ownership and social justice, and raises the question of how we can collectively steer research practices towards desirable futures. We believe that decisions on when, where and for what purpose this technology will be applied are also political, not least in terms of their consequences. Thus, directing this discovery towards responsible applications and desirable futures, cannot be left to the sole responsibility of scientists, experts and the industry.

This international symposium aims to discuss the potential impact and challenges while exploring the scientific, ethical, and societal issues inherent in genome-editing research. Inputs by key-note speakers, the presentation of three scenarios where the application of CRISPR is envisioned, interdisciplinary panels, as well as formats encouraging the interaction of the audience with speakers will promote engagement through dialogue.

Speakers:

KRZYSZTOF CHYLINSKI, Vienna BioCenter
JIM DRATWA, EC, European Group on Ethics in Science and New Technologies
CHRISTIANE DRUML, UNESCO Chair on Bioethics, Medical University of Vienna
ULRIKE FELT, University of Vienna
KARIN GARBER, „Open Science", Vienna
FLORIAN GREBIEN, Ludwig Boltzmann Institute for Cancer Research, Vienna
SHEILA JASANOFF, Harvard Kennedy School
INGRID KELLY, University of Vienna
THEODORA KOTSAKA, Nicos Poulantzas Institute, Athens
STUART NEWMAN, New York Medical College
SHOBITA PARTHASARATHY, University of Michigan
HEIDEMARIE PORSTNER, GLOBAL 2000 – Friends of the Earth Austria
BARBARA PRAINSACK, University of Vienna
ALEXANDRA RIBARTIS, AGES, Vienna
PETER SCHLÖGELHOFER, University of Vienna
RENÉE SCHROEDER, University of Vienna
GIUSEPPE TESTA, European Institute for Oncology, Milan
KIKUE TACHIBANA-KONWALSKI, Institute of Molecular Biotechnology, Vienna
CHRISTOPH THEN, Testbiotech, Munich
NIKOLAI WINDBICHLER, Imperial College London

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3.6 KLI Colloquia

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

RIANA BETZLER
KLI
Empathy as a "Looping Kind"

DANIEL S. BROOKS
KLI
In Defense of Levels: Layer Cakes and Guilt by Association

CALIN GUET
IST Austria
Can Systems and Synthetic Biology Teach Us New Biology?

SEBASTIAN VIEHMANN
University of Vienna
The Potential of Geochemistry to Reconstruct the Habitats of the Origin of Life

BERNAT COROMINAS-MURTRA
Medical University of Vienna
Open-Ended Evolution: Characterization, Consequences, and Paradoxes

MIHAELA PAVLICEV
Cincinnati Children´s Hospital Medical Center
Evolutionary Origin, Modification, Effect and Importance: The Riddle of Female Orgasm

THOMAS KÖNIG
Institute of Advances Studies, Vienna
In the Name of Science: Some Reflections on Peer Review

MARIA KRONFELDNER
Central European University Budapest
On How to Distinguish Channels of Inheritance

MARKUS ERONEN
KU Leuven
The Nature of Hierarchical Organization in Biology

JAMES DIFRISCO
KLI
Introduction to Process Philosophy of Biology

TOMAS EICHLER
IMP Vienna
Learn How You Wake up from Sleeping Worms: Evolution of Brain States

MAARTEN LARMUSEAU
KU Leuven
Long-Term Trends in Human Cuckoldry Behavior

STEFANIE WIDDER
KLI
Case-Studies of Structure–Function Mapping in Microbial Communities

NICK MONK
University of Sheffield
Dynamical Systems and a Process Perspective on Life

MATTHEW SLATER
Bucknell University
Tissue and Organ Types Within and Across Species

JAN-HENDRIK HOFMEYR
Stellenbosch University
How the Cell Makes Itself: The Functional Organisation that Underlies Self-Fabrication

TIAGO PAIXAO
IST Austria
The Complexity of Adaptation: Evolutionary Dynamics on Correlated Sequence Spaces

THOMAS CHARTIER
EMBL Heidelberg
Associative Learning, a Crucial Cognitive Innovation in Animal Evolution

STANISLAV Y. SHVARTSMAN
Princeton University
Switches, Clocks, Patterns, and Waves: Chemical Dynamics in Embryos

WESLEY ANDERSON
KLI
Introduction to Causal Modeling; Or, Tools for Baby Bear Theories

NADIA SCOTT
KLI
The Evolutionary Development of the Primate "Brain"

Jan BAEDKE
Ruhr University Bochum
Losing the Organism in Evolutionary Theory… Once Again

BRIAN G. HENNING
Gonzaga University, Spokane
On the Need for a New Ontology of Individuality

JACQUELINE MOUSTAKAS-VERHO
University of Helsinki
Of Teeth and Scales: Developmental Experiments in Organs of Skin

HAROLD DE VLADAR
Parmendides Foundation, Pullach
Cognitive Cultural Dynamics

LYNN CHIU
University of Bordeaux
Life Enabled: A General Principle of Biological Identity

THOMAS PÖLZLER
University of Graz
Moral Realism, Evolution, and Folk Metaethics

STUART A. NEWMAN
Medical College New York
Inherency in Development and Evolution

MANFRED D. LAUBICHLER
Arizone State University
The Governance of Innovation Processes

ROBERT C. POWER
Max Planck Institute for the Science of Human History, Jena
Dental Calculus as a Window into Ancient Diets and the Ecology of Paleolithic People

EVA FERNÁNDEZ-LABANDERA
KLI
Tracing Back Homeostasis: A Conceptual Inquiry

FRANK ZACHOS
Natural History Museum Vienna
The Species Problem – Practical Ramifications of a Theoretical Conundrum

MURILLO PAGNOTTA
KLI
Towards a Relational-Processual Approach to Social Learning and 'Culture': Integrating Developmental Systems Theory, Radical Embodiment Approach, and Relational Thinking

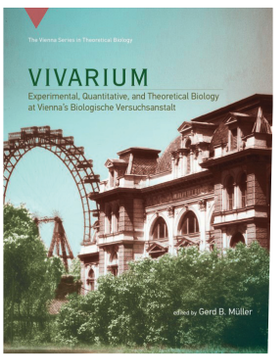
BRIAN MCLOONE
Higher School of Economics, Moscow
The Impossible Worlds Problem for Fictionalist Accounts of Evolutionary Models

Publications

Scientific publications and presentations of fellows and staff members of the KLI in 2017.

4.1 Vienna Series in Theoretical Biology

The 'Vienna Series' is published by The MIT Press as a book series. Books are mainly based on the Altenberg Workshops and the resulting contributions and new syntheses. The book projects are subjected to a reviewing process by The MIT Press.



Volume 19:

MÜLLER GB, ed
Vivarium
Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt

4.2 Professional Papers and Books

ALTENBERG L.
Probing the Axioms of Evolutionary Algorithm Design
Commentary on "On the Mapping of Genotype to Phenotype in Evolutionary Algorithms" by Peter A. Whigham, Grant Dick, and James Maclaurin
Programming and Evolvable Machines 18: 363–367

ALTENBERG L, LIBERMAN U, FELDMAN MW.
Unified Reduction Principle for the Evolution of Mutation, Migration, and Recombination
Proceedings of the National Academy of Sciences 114: E2392–E2400

BROOKS DS.
In Defense of Levels: Layer-Cakes and Guilt by Association
Biological Theory 12: 142–156

60 CAZZOLLA GATTI R, HORDIJK W, KAUFFMAN S.
Biodiversity is Autocatalytic
Ecological Modelling 346: 70–76

DI COLA V, BROENNIMANN O, PETITPIERRE B, BREINER FT, D'AMEN M, RANDIN C, ENGLER R, POTTIER J, PIO D, DUBUIS A, PELLISIER L, MATEO RG, HORDIJK W, SALAMIN N, GUISAN A.
Ecospat: An R Package to Support Spatial Analyses and Modelling of Species Niches and Distributions
Ecography 40: 774–787

DiFRISCO J.
Token Physicalism and Functional Individuation
European Journal for Philosophy of Science: 1–21

DiFRISCO J.
Functional Explanation and the Problem of Functional Equivalence
Studies in History and Philosophy of Science Part C 65: 1–8

DiFRISCO J.
Time Scales and Levels of Organization
Erkenntnis 82: 795-818

FISCHER B, MITTEROECKER P.
Allometry and Sexual Dimorphism in the Human Pelvis
The Anatomical Record 300: 698–705

FISCHER B.
Werden wir unsterblich?
In: Werden wir auf dem Mars leben? (Kafka M, Pennersdorfer P. eds), pp. 115–117
Vienna: Brandstätter Verlag

FISCHER B, FLECK M, SIMON UK.
Am Puls: Biologie 5
Biology text book for high school biology, Volume 1
Vienna: oebv (Österreichischer Bundesverlag Schulbuch)

GONZALEZ-CABRERA I.
On Social Tolerance and the Evolution of Human Normative Guidance
British Journal for the Philosophy of Science. doi:10.1093/bjps/axx017

GONZALEZ-CABRERA I.
Moving Beyond Dichotomies: Liao S. Matthew (ed.), Moral Brains: The Neuroscience of Morality
Philosophy & Biology 32: 1035–1046

HORDIJK W, STEEL M.
Chasing the Tail: The Emergence of Autocatalytic Networks
BioSystems 152: 1–10

HORDIJK W.
Autocatalytic Sets and RNA Secondary Structure
Journal of Molecular Evolution 84: 153–158

HORDIJK W.
Autocatalytic Confusion Clarified
Journal of Theoretical Biology 435: 22–28

HORDIJK W.
Can Computers Help Us Conserve Biodiversity?
The Naked Scientists, www.thenakedscientists.com/articles/sciencefeatures/cancomputershelpusconservebiodiversity

HORDIJK W.
Citizen Science: Facts or Fake News?
Plus magazine, plus.maths.org/content/citizensciencepublicdatabasesandbitmaths

HORDIJK W.
Cause and Process in Evolution
Extended Evolutionary Synthesis Blog, extendedevolutionarysynthesis.com/workshopreportcauseandprocessinevolution

HORDIJK W.
Citizen Science: The Statistics of Language
Plus magazine, plus.maths.org/content/statisticslanguage

HORDIJK W.
An Unconventional Place for Unconventional Science
Extended Evolutionary Synthesis Blog, extendedevolutionarysynthesis.com/anunconventionalplaceforunconventionalscience

HORDIJK W.
The Origin of Life: A Selfish Act or a Cooperative Effort?
TVOL, evolutioninstitute.org/article/theoriginoflifeaselfishactoracooperativeeffort

KEIJZER F, ARNELLOS A.
The Animal Sensorimotor Organization: A Challenge for the Environmental Complexity Thesis
Biology & Philosophy 32: 421–441

LANGE A, MÜLLER GB.
Polydactyly in Development, Inheritance, and Evolution
The Quarterly Review of Biology 92: 1–38

MITTEROECKER P, HUTTEGGER S, FISCHER B, PAVLICEV M.
Reply to Grossman: The Role of Natural Selection for the Increase of Caesarean Section Rates
Proceedings of the National Academy of Sciences 114: E1305.

MÜLLER GB.
Vivarium - Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt
Cambridge: MIT Press

MÜLLER GB.
Why an Extended Evolutionary Synthesis Is Necessary
Interface Focus 7: 1–11

MÜLLER GB.
Biologische Versuchsanstalt: An Experiment in the Experimental Sciences
In: Vivarium - Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt (Müller GB, ed), pp 3–18
Cambridge: MIT Press

MÜLLER GB.
The Substance of Form: Hans Przibram's Quest for Biological Experiment, Quantification, and Theory
In: Vivarium - Experimental, Quantitative, and Theoretical Biology at Vienna's Biologische Versuchsanstalt (Müller GB, ed), pp 135-163
Cambridge: MIT Press

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SARTO-JACKSON I, LARSON DO, CALLEBAUT W.
Culture, Neurobiology, and Human Behavior: New Perspectives in Anthropology
Biology & Philosophy 32: 729–748

SCHMIDT MFH, GONZALEZ-CABRERA I, TOMASELLO M
Children's Developing Metaethical Judgments
Journal of Experimental Child Psychology 164: 163–177

SHIRT-EDISS B, MURILLO-SÁNCHEZ S, RUIZ-MIRAZO K.
Framing Major Prebiotic Transitions as Stages of Protocell Development: Three Challenges for Origins-of-Life Research
Beilstein Journal of Organic Chemistry 13: 1388–1395

TOMASELLO M, GONZALEZ-CABRERA I.
The Role of Ontogeny in the Evolution of Human Cooperation
Human Nature 28: 274–288

TURNER D.
Paleobiology's Uneasy Relationship with the Darwinian Tradition: Stasis as Data
In: The Darwinian Tradition in Context: Research Programs in Twentieth Century Evolutionary Biology (Delisle R, ed), pp 333–352
Dordrecht: Springer

VERD B, CROMBACH A, JAEGER J.
Dynamic Maternal Gradients Control Timing and Shift-Rates for Drosophila Gap Gene Expression
PLoS Computational Biology 13, e1005285.

WOTTON KR, ALCAINE-COLET A, JAEGER J, JIMÉNEZ-GURI E.
Non-Canonical Dorsoventral Patterning in the Moth Midge *Clogmia albipunctata*
EvoDevo 8: 20

XENAKIS I, ARNELLOS A.
Aesthetics as Evaluative Forms of Agency to Perceive and Design Reality: A Reply to Aesthetic Realism
New Ideas in Psychology 47: 166–174

4.3 Forthcoming Publications

ANDERSON WH.
Discovering Selection for Altruism
Philosophy of Science

AYENI FA, BIAGI E, RAMPELLI S, FIORI J, SOVERINI M, AUDU HJ, CRISTINO S, CAPORALI L, SCHNORR S, CARELLI V, BRIGIDI P, CANDELA M, TURRONI S.
Infant and Adult Gut Microbiome and Metabolome in Rural Bassa and Urban Settlers from Nigeria
Cell Reports

BROOKS DS
A New Look at Levels of Organization
Biology & Philosophy

BROOKS DS, ERONEN M.
The Significance of Levels of Organization: A Heuristic Approach
Studies in History and Philosophy Part C

BROOKS DS, STIEFEL K.
Why Are there no Successful Brain Simulations (Yet)?
Theory in Biosciences

CAZZOLLA GATTI R, FATH B, HORDIJK W, KAUFFMAN S, ULANOWICZ R.
Niche Emergence as an Autocatalytic Process in the Evolution of Ecosystems
Journal of Theoretical Biology

BETZLER RJ.
How to Clarify the Aims of Empathy in Medicine
Medicine, Healthcare, and Philosophy

DiFRISCO J.
Biological Processes: Criteria of Identity and Persistence
In: Everything Flows. Towards a Processual Philosophy of Biology
(Nicholson DJ, Dupré J, eds)
Oxford: Oxford University Press

DiFRISCO J.
Kinds of Biological Individuals: Sortals, Projectibility and Selection
The British Journal for the Philosophy of Science

ERONEN M, BROOKS DS.
Levels of Organization in Biology
Stanford Encyclopedia of Philosophy

FAUST K, BAUCHINGER F, DE BUYL S, LAHTI L, WASHBURNE A, LAROCHE B, GONZE D, WIDDER S.
Community Model Selection from Microbial Time Series Data
Microbiome

GAWNE R, McKENNA KZ, NIHOUT HF.
Unmodern Synthesis: Developmental Hierarchies and the Origin of Phenotypes
BioEssays

GONZALEZ-CABRERA I.
Peer Competition and Cooperation
In: Encyclopedia of Evolutionary Psychological Science
New York: Springer

HORDIJK W, STEEL M, DITTRICH P.
Autocatalytic Sets and Chemical Organizations: Modeling Selfsustaining Reaction Networks at the Origin of Life
New Journal of Physics

MÜLLER E, FAUST K, HEROLD M, MARTINEZ ARBAS S, WIDDER S, WILMES P.
Using Metabolic Networks to Resolve Ecological Properties of Microbiome
Current Opinion in Systems Biology

PETERSON T, MÜLLER GB.
Developmental Finite Element Analysis (devFEA): A Quantifying Tool for the Study of Developmental Biomechanics Using Cichlid Pharyngeal Jaws
PlosOne

66 PÉREZ-BEN C, SCHOCH R, BÁEZ AM.
Miniaturization and Morphological Evolution in Paleozoic Relatives of Living Amphibians: A Quantitative Approach
Paleobiology

RAM Y, ALTENBERG L, LIBERMAN U, FELDMAN W.
Generation of Variation and a Modified Mean Fitness Principle: Necessity Is the Mother of Genetic Invention
Theoretical Population Biology

SARTO-JACKSON I.
Wired for Social Interaction: What an Interdisciplinary Approach from Neurobiology, Evolutionary Biology, and Social Education Work Can Teach Us about Psychological Trauma
International Journal of Child, Youth and Family Studies

SARTO-JACKSON I.
Time for a Change: Topical Amendments to the Medical Model of Disease
Biological Theory

SARTO-JACKSON I.
Out of Order: Function and Malfunction in the Biological and Biomedical Sciences
Biological Theory

SCHNORR SL, HOFMAN CA, NETSHIFHEFHE SR, DUNCAN FD, HONAP TP, LESNIK J, LEWIS CM.
Taxonomic Features and Comparisons of the Edible Fungus-Farming Termite Microbiome and Implications for Human Evolution (*Macrotermes falciger; Myrmicaria natalensis*)
PeerJ

SCOTT N, STRAUSS A, NEUBAUER S, HUBLIN JJ, GUNZ P.
Covariation of the Endocranium and the Splanchnocranium Changes with Postnatal Ontogeny in Extant Great Apes
Biology Letters

SCOTT N.
Not just Size and Shape: Further Directions for Human Evolutionary Neuroscience
Frontiers in Neuroscience

TURNER D.
Three Kinds of Realism about Historical Science
In: The Routledge Handbook of Scientific Realism (Saatsi J, ed)
London: Routledge

VERD B, CLARK E, WOTTON KR, JANSSENS H, JIMÉNEZ-GURI E, CROMBACH A, JAEGER J.
A Damped Oscillator Imposes Temporal Order on Posterior Gap Gene Expression in Drosophila
PLoS Biology

4.4 Journal *Biological Theory*

Volume 12, Issue 1:

LINDE-MEDINA M.
A Taxonomy of Non-Fitness

FORSDYKE DR.
Speciation: Goldschmidt's Chromosomal Heresy, Once Supported by Gould and Dawkins, Is Again Reinstated

BARBIERI M.
How Did Eukaryotes Evolve?

BOURRAT P.
Explaining Drift from a Deterministic Setting

DU PLESSIS NM.
A Rule for Naming Objects

LLOYD EA, GOULD SJ.
Exaptation Revisited: Changes Imposed by Evolutionary Psychologists and Behavioral Biologists

Volume 12, Issue 2:

BLUTE M.
Three Modes of Evolution by Natural Selection and Drift: A New or an Extended Evolutionary Synthesis?

PLANER RJ.
Protolanguage Might Have Evolved Before Ostensive Communication

SAGOFF M.
On the Definition of Ecology

STERNER B, FRANZ NM.
Taxonomy for Humans or Computers? Cognitive Pragmatics for Big Data

VAN HATEREN JH.
A Unifying Theory of Biological Function

KUPIEC J-J.
Mechanistic Development

Volume 12, Issue 3:

ALBERTAZZI L, CANA L, CHISTÈ P, DE ROSA M, MICCIOLO R, MINELLI A.
Reconsidering Morphology Through an Experimental Case Study

BROOKS DS.
In Defense of Levels: Layer Cakes and Guilt by Association

FORSDYKE DR.
Base Composition, Speciation, and Why the Mitochondrial Barcode Precisely Classifies

SUZUKI DG, TANAKA S.
A Phenomenological and Dynamic View of Homology: Homologs as Persistently Reproducible Modules

WU J.
A Note on Altruism in Asymmetric Games: An Indirect Evolutionary Approach

Volume 12, Issue 4:

STERELNY K, HISCOCK P.
The Perils and Promises of Cognitive Archaeology: An Introduction to the Thematic Issue

SHAW-WILLIAMS K.
The Social Trackways Theory of the Evolution of Language

PLANER RJ.
Talking About Tools: Did Early Pleistocene Hominins Have a Protolanguage?

KILLIN A.
Plio-Pleistocene Foundations of Hominin Musicality: Coevolution of Cognition, Sociality, and Music

STERELNY K.
Artifacts, Symbols, Thoughts

STINER MC.
Love and Death in the Stone Age: What Constitutes First Evidence of Mortuary Treatment of the Human Body?

JOHNSON M.
Seeking Speaker Meaning in the Archaeological Record

GODFREY-SMITH P.
Senders, Receivers, and Symbolic Artifacts

4.5 Scientific Presentations

BETZLER RJ.
What Is the Place of Empathy in a Diverse Society?
International Tübingen Symposium on Ethics: The Value of [Not] Being Diverse, University of Tübingen

BETZLER RJ.
Looping Patterns by Degree
Aristotelian Society and Mind Association, University of Edinburgh

BETZLER RJ.
The Empathic Ideal in Modern Medicine
Doctor, Doctor: Global and Historical Perspectives on the Doctor-Patient Relationship, University of Oxford

CHARTIER T.
Marine Worms and the Evolution of Learning
Messerli Institut, Vienna

DiFRISCO J.
Process Thinking for Evo-Devo
Summer School in Evolutionary Developmental Biology,
Istituto Veneto di Scienze Lettere ed Arti, Venice

DiFRISCO J.
Process Ontology of Biological Individuals
DK Program, The Sciences in Historical, Philosophical, and Cultural Contexts
University of Vienna

DiFRISCO J.
Individuals and Biological Kinds:
Countability, Projectibility, and Selection
Colloquium on Theoretical Analytical Philosophy, Aarhus University

DiFRISCO J.
Individuals, Characters, and Biological Kinds
Immunoconcept Lab, University of Bordeaux

FISCHER B.
Kindsköpfe und evolutionärer Pfusch
MINT-Awards-Gala, Vienna

FISCHER B.
Enge Becken, große Köpfe und die menschliche Evolution
University Clinic for Obstetrics and Gynecology, Medical University of Vienna

FISCHER B, MITTEROECKER P.
Gestaltvariation im Becken
Seminar des Kontinenz- und Beckenbodenzentrums, Medical University of Vienna

HORDIJK W.
Simulating Autocatalytic Sets in Compartments
Conference "SysChem 2017", Sopron

HORDIJK W.
Autocatalytic Sets and Chemical Organization
Dagstuhl Seminar "Algorithmic Cheminformatics",
Schloss Dagstuhl, Wadern

HORDIJK W.
Autocatalytic Sets and RNA Secondary Structure
TBI Winterseminar, Bled

HORDIJK W.
Autocatalytic Sets and RNA Secondary Structure
COST Action CM1304 WG2 Meeting, ENS, Paris

HORDIJK W.
Autocatalytic Sets and the Origin of Life
eScience Center, Amsterdam

HORDIJK W.
Autocatalytic Sets and the Origin of Life
University of Uppsala

HORDIJK W.
Autocatalytic Sets and the Origin of Life
University of Oxford

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Autocatalytic Sets and the Origin of Life
University of Sheffield

HORDIJK W.
Autocatalytic Sets and the Origin of Life
Newcastle University, Newcastle upon Tyne

HORDIJK W.
Autocatalytic Sets and the Origin of Life
University of Vienna

HORDIJK W.
Autocatalytic Sets and the Origin of Life
University of Tübingen

HORDIJK W.
Autocatalytic Sets and the Origin of Life
CERN, Geneva

HORDIJK W.
Autocatalytic Sets and the Origin of Life
Kyoto University

HORDIJK W.
Autocatalytic Sets and the Origin of Life
Ben-Gurion University, Beersheba

HORDIJK W.
Autocatalytic Sets and the Origin of Life
Tel Aviv University

MÜLLER GB.
Towards an Extended Evolutionary Synthesis
10-on-10: The Chronicles of Evolution. Nanyang Technical University, Singapore

MÜLLER GB.
The Morphogenetic Basis of Discontinuous Variation
International Conference "On the Nature of Variation", University of Lisbon

MÜLLER GB.
The Extended Synthesis as a Work in Progress
Postgraduate School of Philosophy, Ethics, and Ethology. Università di Cassino e del Lazio Meridionale, Cassino

MURILLO SANCHEZ S.
Building Bridges between Chemistry and Biology: Fatty Acids Enhance Hydrophobic Peptide Formation
Institut de Science et d'Ingénierie Supramoléculaires(ISIS), University of Strasbourg

SARTO-JACKSON I.
Where Neuroscience Meets Anthropology: Neuroplasticity in Cultural Contexts
MEi:CogSci Conference, Eötvös Loránd University (ELTE), Budapest

SARTO-JACKSON I.
Revisiting Conceptual Frameworks of Psychopathologies: The 'Drug-centered' Versus the 'Disease-centered' Model
International Society for the History, Philosophy, and the Social Sciences of Biology 2017 Meeting, Sao Paulo

SARTO-JACKSON I.
Fragility, Robustness, and Antifragility of Biological Neural Networks
Middle European Interdisciplinary Master Programme in Cognitive Science, University of Vienna

SCHNORR S.
Can Honey Consumption Be Detected from Metagenomic Gut Microbiome Data?
87th Meeting of the American Association of Physical Anthropologists, Austin, TX

WIDDER S.
From Keystones to Community Dynamics in Microbial Communities
University of Bordeaux

WIDDER S.
Community Dynamics in the CF Lung Microbiome
Theodor Escherich Symposium, Medical University Graz

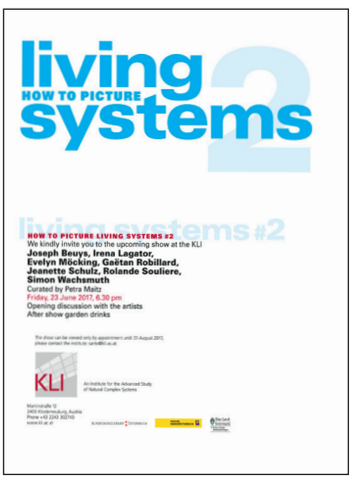
Further Activities

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

5.1 KLI Website

The KLI commissioned the design of a new website which was launched on 6 October 2017. The new website features a graphically appealing design, versatile technical applications, and high usability. In addition, the website provides a backend integration of a full-featured database that serves the KLI fellows for searching and lending of books of the complete KLI/Callebaut library.

5.2 Arts & Science Events



How to Picture Living Systems 2

23 June 2017

KLI Klosterneuburg
Curated by: Petra Maitz

Topic

In many natural systems, an equilibrium is prerequisite to the functioning of a system. In the process of transformations, in biochemical terms, limit values are often exceeded until an equilibrium is established once again. Today, we know that we should be able to represent everything we can record or observe – and that is precisely the great challenge our high-tech and machine-dependent world faces. What can machines represent and what not? In the microstructure of the animate, many factors are controlled by feedback mechanisms. In the cultural evolutionary development of humans, though, such feedback loops are almost invisible. Does cultural anthropological progress exist? In art, too, we are currently seeing the coexistence of purely commercial objectives and, at the same time, an approach that is very strongly orientated towards science and art.

For the second time, we are presenting a series of artistic positions that are convincing in their aesthetic characteristic and manifestation. The "Epicycles of Artistic Discoveries," a diagram by German artist Jeanette Schulz who had chosen to live in Vienna, but sadly died much too young, shows us that scientific thought often needs to draw from other sources. For years, Jeanette formulated her work as research on her own body and interpreted her poor health by means of astonishingly humorous stimulating paroles. She practiced the growth of thought using her left knee. "I always think with my left knee anyway," she would say, quoting one of Joseph Beuys' bon mots. On the interface of indigenous culture and white western art, performative works with co-operative co-existence had already been staged fifty years ago. Joseph Beuys and

the Coyote. His first trip to the USA followed an invitation from René Block to his New York Gallery in 1974. He had developed a special ritual to come to terms with the USA. He didn't want to see anything around him at all and arrived at the gallery blindfolded by ambulance.

This documentary movie serves as a basis for today's reflections on Beuys' oeuvre as it is perceivable in the works of Australian-Canadian artist Rolande Souliere. She embroiders Beuys' eyes and mouth in an indigenous fashion on a black and white photograph of his face. An incredible intervention in historiography: by doing that, she emphasizes the ethnically-related interpretation of art and attributions. "How to Picture Living Systems" becomes an inversion of the topical focus on biology and art. Simon Wachsmuth's work, which is also of a cultural-theoretical nature, consists of associative thoughts and referential derivations of the historical narratives of cast-bronze and copying, and analyses economies of labour division. Wachsmuth has for quite a while dealt with the cultural construct of nature, the forms of its simulation and control as well as their significance in cultural-historical discourse, as Cosima Rainer once put it. What one sees here, however, is merely a mini setting as an example of the experimental arrangement.

Copyright: Simon Wachsmuth

Young German artist Evelyn Möcking applies her interpretation of material characteristically to all her sculpturally aesthetical forms, for she paints with animal fat, or lets it paint itself, as she puts it. Fat distributes itself uncontrolled across the carrier, i.e. paper. Biology speaks its language through the actions of the artist; a highly sublime and extremely direct handling of organic material. She does this kind of work as if it were an appropriation, introducing us to the possibilities of reanimation through the confrontation with death.

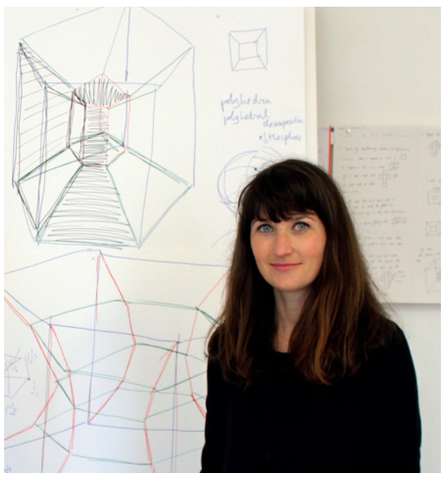
I would like to draw your attention to the video projection and installation in the vaults of the KLI of this exhibition. In the younger scene, Gaetan Robillard has for some time gained a reputation in France for his advanced experiments that are represented in forms of art. It is sometimes difficult to recognize the connotations with mathematical conditionalities of his procedure. Nevertheless, the aesthetic results are convincing and so stunningly engaging that, in essence, this example of artistic investigation casts a kind of spell on us that effortlessly illuminates the fascination of both disciplines. More than ever, contemporary co-productions between natural science and art are an important component of our day and age. Today, at a time when biodiversity is threatened by extinction, young artists are building connections that will enrich art and science and put them in a broader context.

Copyright: Gaetan Robillard

Sponsored by Bundeskanzleramt Abteilung Kunst & Kultur and by Land Niederösterreich Abteilung Kunst & Kultur.

BUNDESKANZLERAMT ÖSTERREICH

KULTUR NIEDERÖSTERREICH



Isomorphology and Isomorphogenesis

3 May 2017

KLI Klosterneuburg
Gemma Anderson

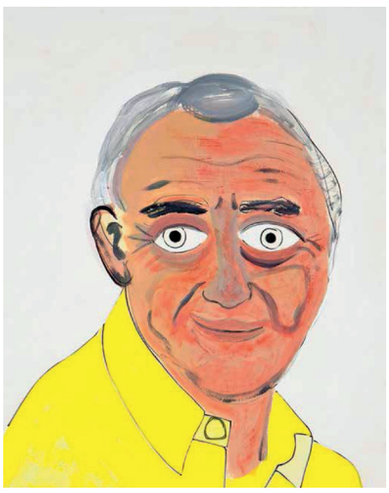
Exhibition

Die nordirische Künstlerin Gemma Anderson wurde von einer Fachjury für das Programm 2017 ausgewählt und zeigt in einer Kooperation des Konrad Lorenz Instituts für Evolutions- und Kognitionsforschung (KLI) mit KulturKontakt Austria mit Hand kolorierte Radierungen und Aquarelle. Mit Hilfe dieser vereint sie Experiment und Theorie auf Basis ihrer Erfahrungen aus der Arbeit mit Forschern in theoretischen und empirischen Wissenschaftszweigen.

Andersons Methode, genannt Isomorphogenese, ist eine Zeichnungspraxis oder ein Experiment, das die Darstellungsmöglichkeiten von Formen als einen dynamischen und formativen Prozess erforscht.

Als Isomorphologie bezeichnet sie eine vergleichende, zeichnungsbasierte Methode der Untersuchung von gemeinsamen Formen der Tier-, Mineral- und Pflanzenstrukturen. Als ganzheitlicher und visueller Ansatz zur Klassifikation verläuft die Isomorphologie parallel zur wissenschaftlichen Praxis, wird aber dem Kunstbereich zugezählt.

Andersons künstlerisch-forschender Ansatz ist komplementär zur Wissenschaft und beschäftigt sich mit Beziehungen, die in der wissenschaftlichen Klassifikation von tierischen, pflanzlichen und mineralischen Strukturen nicht erfasst werden können. In diesem Zusammenhang erforscht die Künstlerin den erkenntnistheoretischen Wert des Zeichenprozesses.



Grüße aus Galápagos

13 October 2017

KLI Klosterneuburg
Anton Herzl

Exhibition

Spuren der Evolutions- und Kognitionsforschung im Werk Anton Herzls
Vernissage Freitag, 13.10.2017 ab 18h

Begrüßung:
Prof.DDr. Gerd B. Müller, Präsident des KLI
Univ. Prof. em. Herbert Lachmayer

5.3 Prizes

Award of the Government of Lower Austria
for Barbara FISCHER
5 October 2017

Schloss Grafenegg

Organization: State Government of Lower Austria

Postdoctoral fellow Barbara Fischer received the 2017 Science Award of the Government of Lower Austria (Anerkennungspreis) for her work on the evolution of the human pelvis. These awards recognize special scientific achievements of a researcher working in Lower Austria. The science prizes 2017 were awarded at the yearly Science Gala in Grafenegg on October 5th, 2017.

Barbara is an evolutionary biologist who studies the obstetric dilemma and why childbirth is so hard in humans. In comparison to other primates, the heads of human neonates are remarkably large in comparison to the maternal pelvis. Barbara's research deals with the question why this situation persists, and why evolution was so far unable to solve this dilemma.

Award „Best Free Talk"
for Stefanie WIDDER
13 October 2017

Theodor Escherich Symposium
Medical University Graz

The 4th Theodor Escherich symposium on medical microbiome research hosted international experts in the field and aimed at fostering the medical perspective of microbiome research.

5.4 Public Outreach

„Science Talk"
ORF3 Wissenschaftstalk
18 October 2017

Copyright: ORF

Postdoctoral fellow Barbara Fischer was an invited talk show guest for the program 'Science Talk' on Austrian TV: Discussing modes of human childbirth and Caeserean section rates with an obstetrician and a midwife.

5.5 Acknowledgment

The KLI is grateful to the Office of the State Government of Lower Austria, Department of Science and Research for additional financial support that contributed to the pursuit of the KLI's scientific endeavors. In addition, the exhibitions curated by Petra Maitz were funded by the Federal Chancellery of Vienna and the Office of the State Government of Lower Austria, Department of Culture and Arts.

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