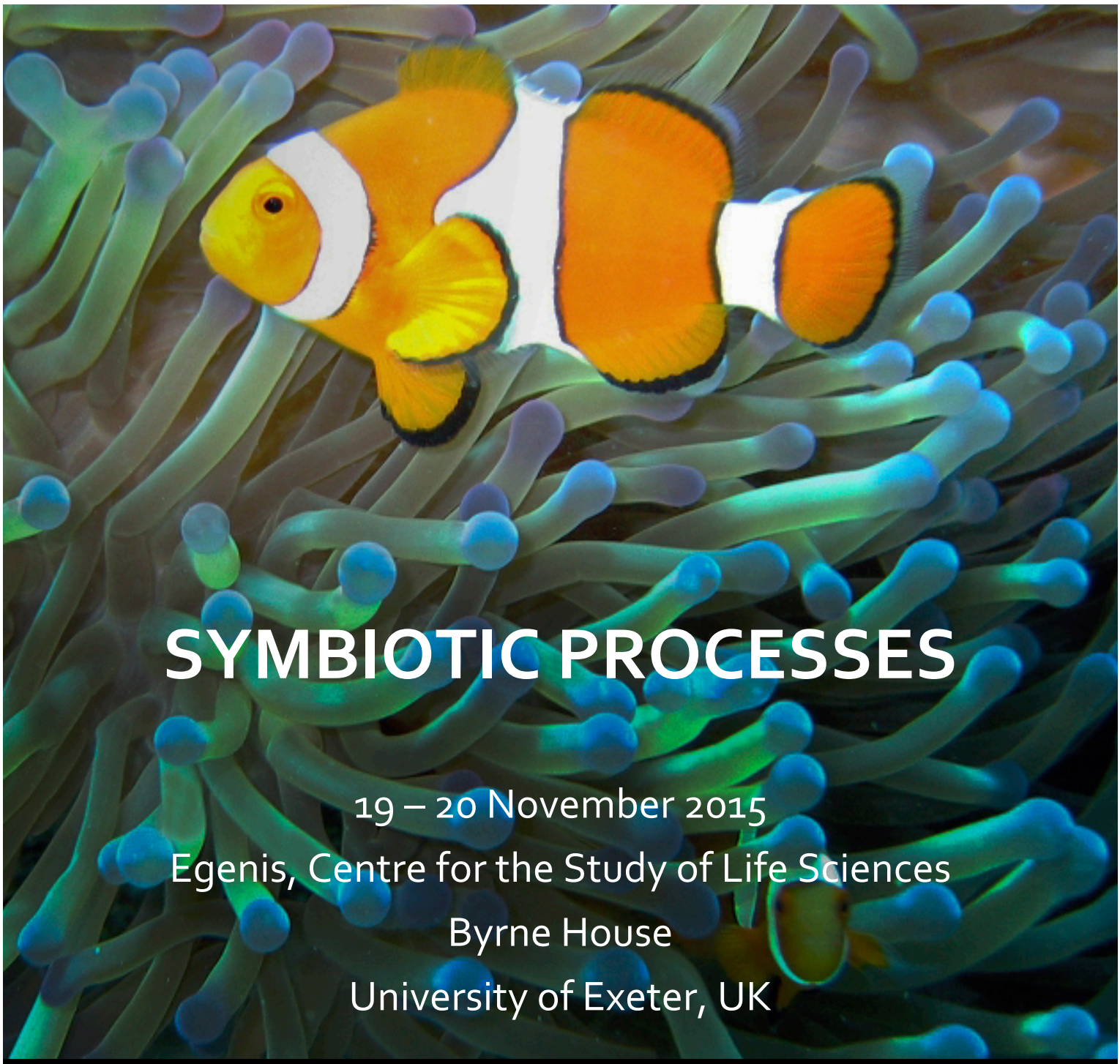


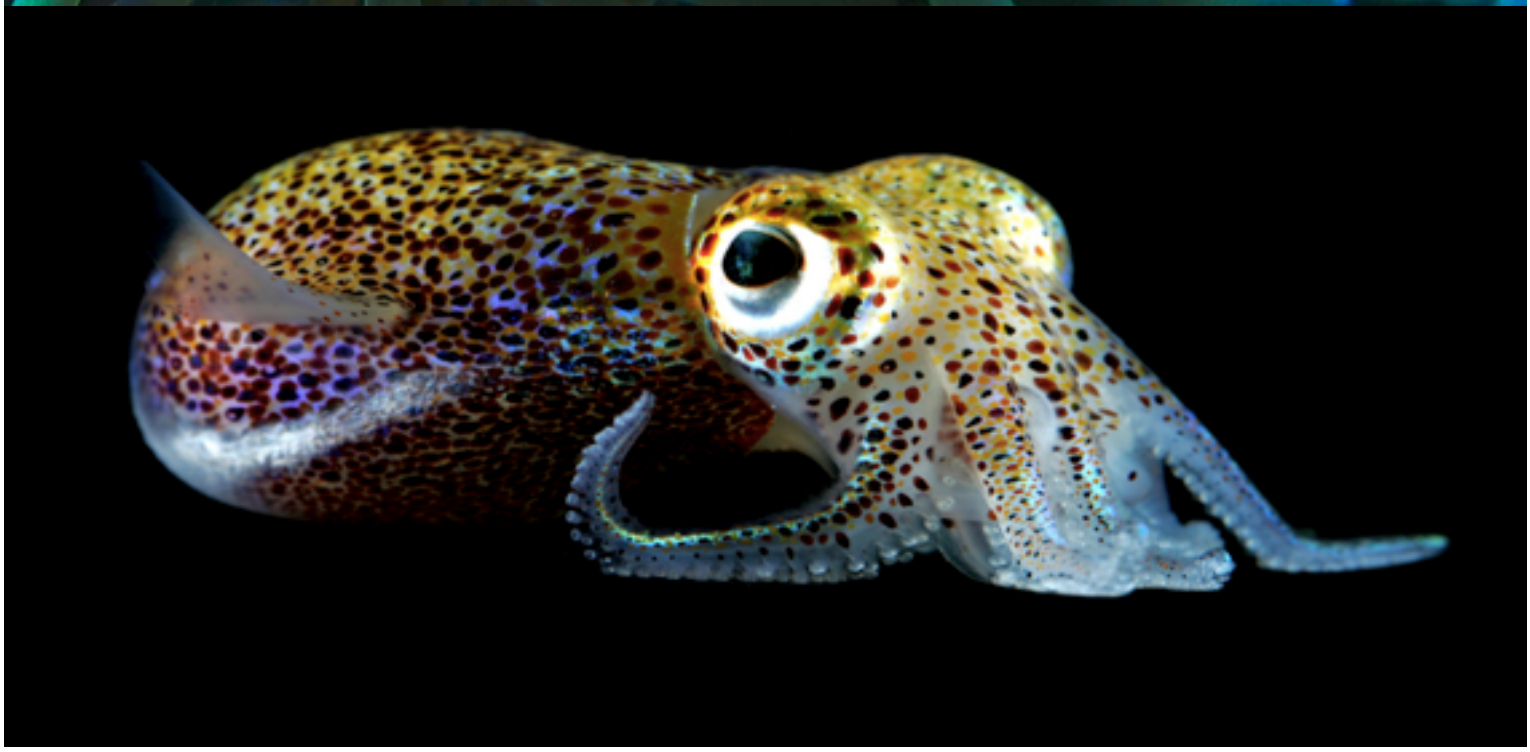
SYMBIOTIC PROCESSES

19 – 20 November 2015

Egenis, Centre for the Study of Life Sciences

Byrne House

University of Exeter, UK



EGENIS – THE CENTRE FOR THE STUDY OF LIFE SCIENCES

Byrne House
St German's Road
Exeter UK EX4 4PJ

UNIVERSITY OF EXETER

European Research Council

Established by the European Commission

About the workshop:

This workshop is part of the ERC-funded project, "A Process Ontology for Contemporary Biology (ProBio)" led by Prof. John Dupré. The project explores the advantages, problems, and implications of a fully processual understanding of living systems. That is to say, instead of the orthodox philosophical view of the world as containing a hierarchy of objects, from a processual perspective life, at least, consists of a hierarchy of processes. Whereas in a world of objects stasis is the default and change requires explanation, the problem in a world of process is rather to explain stability. In the picture being articulated in ProBio, stabilisation of entities at multiple levels (cells, tissues, organisms, etc.) is a consequence of both internal and external processes.

The near omnipresence of symbiosis has been one of the main motivations for the project. The dependence of most life cycles on profound inter-connections with other symbiotic life cycles has been recognised by many philosophers and biologists as problematizing standard assumptions about the nature and boundaries of the organism. This poses ontological questions that, we believe, are much more tractable for a process ontology that is not committed to unambiguous boundaries between entities. This workshop will bring together scientists with various interests in symbiosis and philosophers concerned with biological ontology with a view to an in depth exploration of these basic issues.

Programme:

Thursday, 19. November

9:30 – 10:00am: Registration

Introduction

10:00 – 10:30am: **Dan Nicholson** (University of Exeter, UK)
10:30 – 11:00am **John Dupré** (University of Exeter, UK)

11:00 – 11:30am: Coffee break

Session 1: Plants, Roots and their Allies

11:30 – 12:10pm: **Paul Kenrick** (Natural History Museum, UK)
"Origins of life on land: entanglement of plants, fungi and Earth systems"

12:10 – 12:50pm: **Uta Paszkowski** (University of Cambridge, UK)
"Rhizosphere Communication in Fungal Symbioses of Cereals"

12:50 – 2:00pm: Lunch break

Session 2: Biological Individuals (I)

2:00 – 2:40pm: **Marc Ereshefsky** (University of Calgary, CA)
"Biological Individuality: A Contingent and Open-ended Phenomenon"

2:40 – 3:20pm: **Austin Booth** (Dalhousie University, CA)
"A Comparative Approach to the Evolution of Symbiosis and Integration in Prokaryotes"

3:20 – 4:00pm: **Ellen Clarke** (University of Oxford, UK)
"On biological individuality"

4:00 – 4:30pm: Coffee break

Session 3: Biological Individuals (II)

4:30 – 5:10pm: **Brian Henning** (Gonzaga University, USA)
"On the Need for a New Ontology of Individuality"

5:10 – 5:50pm: **Thomas Pradeu** (University of Bordeaux, FR)
"Host-symbionts interactions in the development of organisms across phyla: Ecosystemic individuality and the unifying role of the immune system"

7:30pm: Conference dinner

Friday, 20. November

Session 4: Microbial Processes

9:30 – 10:10am: **Sven Gould** (University of Duesseldorf, DE)
"Imagine Darwin had known protists"

10:10 – 10:50am: **Stephan Guttinger and John Dupré** (University of Exeter, UK)
"Viruses as Living Processes"

10:50 – 11:20am: Coffee break

Session 5: Organismic Unity

11:20 – 12:00pm: **Spyridon Koutroufinis** (Berlin Institute of Technology, DE)
"Dynamical Depth – A Processual View of Complexity"

12:00 – 12:40pm: **Anne Sophie Meincke** (University of Exeter, UK)
"One or Many? On the Composition of Organisms"

12:40 – 2:00pm: Lunch break

Session 6: Parasites and hosts

2:00 – 2:40pm: **Thierry Rigaud** (University of Bourgogne, FR)
"What is an "individual" characteristics? Lessons from selected natural histories in some symbiotic systems"

2:40 – 3:20pm: **Andrew Jones** (Cardiff University, UK)
"A transcendental perspective on the distinction between symbiosis and parasitism"

3:20 – 3:50pm: Coffee break

Session 7: Mother-Child Dyad

3:50 – 4:30pm: **Elselijn Kingma** (University of Southampton, UK)
"Metaphysics of Pregnancy: the relationship between the fetus and the maternal organism"

4:30 – 5:10pm: **Jonathan Delafield-Butt** (University of Strathclyde, UK)
"Ontological Units in Child Development: Within a body and between bodies"

5:10 – 6:00pm: Plenary discussion/ concluding remarks

6:00pm: End of workshop

Abstracts

(in alphabetical order)

Booth, Austin (Dalhousie University, CA)

A Comparative Approach to the Evolution of Symbiosis and Integration in Prokaryotes

Recent work on the evolution of organismality has argued that the eukaryote cell is an evolutionary outcome in which taxonomically divergent symbiotic partners (of archaeal and bacterial origin) have achieved unprecedented interdependence, but is also similar in kind to other cooperative entities composed of unrelated lineages. Common examples are insects, with their bacterial endosymbionts, and lichen. Each of these organismal individuals can be conceptualized on axes that track the degree of cooperation and conflict among their parts. Organismal individuality is thus treated as a continuously variable condition that is an outcome of evolutionary processes, a theme familiar in transitions theory.

I take this family of views seriously, and acknowledge its potential theoretical utility. One significant problem with cooperative accounts of transitions in organismality, however, is that the literature has thus far been eukaryocentric. Apart from eukaryogenesis itself, there is rarely any mention of exclusively prokaryotic symbioses. But symbiosis and interdependency among prokaryotes is relatively common, and some of these interactions have evolved to be highly specific and obligate. Examination of these cases can complement and extend existing work on symbioses involving eukaryotes.

The primary aim of this talk is to develop a framework that spells out the evolutionary roles of cooperation and interdependence between symbiotic prokaryotic partners, the extent of structural (cellular and genomic) integration between partners, the degree of reproductive synchrony of partners, and ultimately the capacity for autonomous reproduction of the resulting multispecies individual. I examine diverse biological examples, with a focus on cases that demonstrate the utility of the framework. Comparing prokaryotic symbioses of different types, with an emphasis on integrative evolution, not only allows for a richer understanding of the origins and evolution of symbiosis in the microbial world but might also shed light on the origins of the eukaryotic cell.

Clarke, Ellen (University of Oxford, UK)

On biological individuality

What could be more obvious than counting organisms? It's so easy that we count sheep to lull ourselves to sleep. We teach our toddlers their numbers by showing them animals … two ducks, three elephants, and so on. Some philosophers have taken organisms to be the foundational individuals, the only natural particulars. To see why, given all this, the 'problem of biological individuality' has become a huge topic in philosophy of biology, we need to move beyond everyday examples and venture into the weird biological territory where organisms reproduce by tearing themselves in half (as some starfish do); or by growing daughters from the ends of their limbs (as many plants do); or by collaborating with thousands of fellows (like slime moulds).

I defend a view which understands organisms qua evolutionary individuals in terms of levels of selection. I argue that it is necessary to replace our intuitive conception of the organism with one that secures the projectibility sought in evolutionary biological theory. The resulting notion is one that can do work in many domains of interest to philosophers and to human beings. I will explain some of the advantages of adopting this view, and spell out some implications for biological ontology.

Delafield-Butt, Jonathan (University of Strathclyde, UK)

Ontological Units in Child Development: Within a body and between bodies

This paper advances a process ontological view of early embodied experience and its composition within a single body and between bodies. These experiences are atomistic and future-oriented, arranged in a nested hierarchy of conscious purpose that expands in human development beyond the self to include others in discreet, purposeful intersubjective units of engagement. Their origins are evident in the first signs of awareness and purposeful motor activity of the second trimester foetus, whose self-generated and exploratory movements anticipate their sensory consequences. Such early and basic conscious action reveals a primary psycho-motor – or mind-body – process structured by creative agency and anticipated outcome. It reveals a fundamental ontological unit that is intentional, subjective, and objective in the fact of its physical expression. It is also the earliest evidence of embodied consciousness of a sensori-motor kind in human life, and a source of affective and intelligent meaning-making in human culture. From its study, we can generalise to propose basic ontological principles in nature, and probe how ontological wholes can be composed beyond individual bodies. Individual human action, made in intersubjective communication, conveys vital feelings, awareness and intentions of the Self with other persons whose own purposes and feelings shape the other's. We now understand these projects are shared in precise, regularly patterned reciprocal events with common, invariant characteristics of process as basic solitary movement, but are now co-created with another to form something larger than the single Self. Nevertheless, they continue to satisfy individual innate drives to serve the vitality of the Self, enabling growth, development, and learning, within the context of a culture. Thus, this paper proposes generalised units of purpose in life, around which understanding of conscious systems, within and between bodies, can emerge.

Ereshefsky, Marc (University of Calgary, CA)

Biological Individuality: A Contingent and Open-ended Phenomenon

Recent work on multispecies microbial consortia suggests that we should rethink the nature of biological individuality, that standard accounts of individuality are far too restrictive. Microbial consortia fail many of the usual criteria for individuality, yet they exhibit many features of individuals in selection. If such consortia are biological individuals, then a more pluralistic account of individuality is needed. Another lesson is that we should more seriously think about biological individuality as a contingent and open-ended phenomenon.

Gould, Sven (University of Duesseldorf, DE)

Imagine Darwin had known protists

In contrast to the origin of prokaryotic cells that likely arose twice independently but simultaneously, the origin of the eukaryotic cell occurred only once in evolution. Authoritative recent data supports the ring-of-life hypothesis, in which an archaeal host entered an endosymbiotic relationship with a progenitor of today's alpha-proteobacteria; that endosymbiont evolved into the mitochondrion we know today. Ultimately, all macroscopic life (animals and plants) trace back to two such endosymbiotic events: the first one introduced the mitochondrion and gave rise to eukaryotes and the second one introduced eukaryotes to photosynthesis by reducing an endosymbiotic (photoautotrophic) cyanobacterium to the plastid we are familiar with from plants. Darwin knew nothing about this. His theory of evolution is based on the linear inheritance of animal traits through sexual recombination, but especially in the single-celled world (representing the majority of eukaryotic diversity) there is so much more. New photosynthetic supergroups arose through secondary endosymbiosis, the chimeric fusion of two eukaryotic cells. Some phyla exist due to a viral infection and others appear "immortal" as they proliferate solely by fission in the absence of sexual reproduction. There is also lateral gene transfer: the non-sexual, cross-species transfer of individual genes that in a few cases have had a significant impact on the recipients biology. The origin of the eukaryotic cell and some branches of its subsequent evolution are no integral component of the (neo-)darwinian concept. Together with tightly interlocked symbiotic associations they do not challenge the principles of natural selection and fitness, but tree-like evolution and, at least in the single-celled world, our concept of clear boundaries that define a species.

Guttinger, Stephan and Dupré, John (University of Exeter, UK)

Viruses as Living Processes

The view that life is composed of distinct entities with well-defined boundaries has been undermined in recent years by the realisation of the near omnipresence of symbiosis. What seemed to be intrinsically stable entities turn out to be the interactions between a complex set of underlying processes. This has not only presented severe problems for our traditional understanding of biological individuality but has also led some to claim that we need to switch to a process ontology to be able adequately to understand biological systems. A large group of biological entities, however, has been excluded from these discussions, namely viruses. Despite comprising a large part of the proteins, RNA and DNA swirling around in nature, viruses have usually been seen as stable and distinct individuals that do not fit the more integrated and collaborative picture of nature implied by symbiosis. In this paper we will contest this view. We will first discuss some recent findings in virology that show that viruses can be 'nice' and collaborate with their hosts, meaning that they form part of integrated biological systems and processes. We further offer various reasons why viruses should be seen as processes rather than things, or substances. Based on these two claims we will argue that, far from serving as a counterexample to it, the example of viruses actually enables a deeper understanding of the fundamentally interconnected and collaborative nature of nature.

Henning, Brian (Gonzaga University, USA)

On the Need for a New Ontology of Individuality

Western conceptions of individuality have been dominated by the substance traditions' emphases on independence. Whether an individual is defined by its essential independence, as with Aristotle, or by its existential independence, as with Descartes, it is the distinctness, separateness that is the mark of the individual. Further, the denotation of individuality has been dominated by sight, which locates individuality through boundaries that are observable at human spatial and temporal scales. Individuals are visually identifiable by their skin, edge, bark, or membrane. In the modern era, this ontology of individuality as independence often brought about corresponding emphases in the domains of ethics, law, and politics, where concepts such as freedom, responsibility, and autonomy came to dominate. In contradistinction to these dominant ontological traditions, in this presentation I will argue that there is no independence of existence; to exist is to be a constitutively interrelated process. Specifically, using examples from biology (specifically, termites) and earth system science (also known as Gaia theory), I will argue that individuality is ultimately a matter of degree, more or less, and is not best determined by visually identifiable boundaries. I conclude that the ontology of individuality must be fundamentally reconceived along the lines of an organist process metaphysics. A brief discussion of the ethical implications of this ontological shift will be included, time permitting.

Jones, Andrew (Cardiff University, UK)

A transcendental perspective on the distinction between symbiosis and parasitism

We are becoming increasingly aware of our biologically heterogeneous composition. Research has shown that microbiota living on and in our body outnumber our somatic and germ cells 10-fold (Turnbaugh et al., 2007). Such research supports the conception of the body as an assemblage or 'macrobe' but has once again raised the philosophical issue regarding the identity and boundaries that constitute the organism.

How we should conceive of the parasite-host and symbiont-host relations is disputed. Some define parasitism as a sub-division of symbiosis whereas others argue to conflate parasitism and symbiosis consequently makes the scope of symbiosis too broad. Fundamentally, the mutual benefit to fitness that both parties receive through symbiotic relations has led many to consider the symbiont as part of the host. But insofar as the parasite reduces the fitness of the host, we would also be committed to deny that the parasite be considered as part of the organism. Hence, symbiotic processes can only refer to a single organism if parasitism is excluded from the definition of symbiosis. However, we should be cautious of demarcating parasites from symbionts based on adaptationist principles that identify an organism by appealing to increased levels of overall fitness. Research has shown that helminthic infections exerted a selective pressure on our development as decreasing rates of contracting helminthic infection has contributed to cases of 'inflammatory bowel disease, type 1 diabetes, multiple sclerosis, and other conditions' (Weinstock and Elliot, 2014, 3239). In other words, although helminthic infections are parasitic, there are aspects of this relation that have exaptive, and by extension symbiotic, qualities for the host. Thus the difference between symbiosis and parasitism is a gradual difference of degree rather than a difference in kind.

My aim is not to offer a resolution for this dispute, rather I shall assess the preconditions that are necessary to establish these disparate categorisations of symbionts and parasites. I approach these questions from the philosophical position of transcendental idealism formulated by the 18th century German Idealist Immanuel Kant. By establishing the necessary conditions for experience, Kant's critical philosophy exposes

important limitations for metaphysics and morality that culminate in his discussion of organic entities in the second part of his Critique of Judgment. This discussion can contribute to contemporary philosophy of biology insofar as it provides a systematic account of why the organism concept requires us to implement more than is available via experience alone. Hence, when disagreement regarding the boundaries or definition of the organism concept arises transcendental idealism proposes that we assess how the non-experiential grounds for such a definition is primarily formulated.

References

Turnbaugh, P, J. Ley, R, E. Hamady, M. Fraser-Liggett, C, M. Knight, R. and Gordon, J, I. (2007) The Human Microbe Project. Nature. 449 (pp.804-10)

Weinstock, J, V. Elliott, D, E. (2014) Helminth Infections Decrease Host Susceptibility to Immune-Mediated Diseases. The Journal of Immunology. 193 (pp.3239–3247)

Kenrick, Paul (Natural History Museum, UK)

Origins of life on land: entanglement of plants, fungi and Earth systems.

Early life on land was mostly microbial, but sometime during the late Neoproterozoic or early Palaeozoic more complex ecosystems comprising plants, lichens and arthropods became established. The aims of my research are to discover when and how these terrestrial ecosystems first evolved and to understand the consequences for Earth systems (e.g., carbon cycle). Charting the course of events in deep time and their environmental impact makes use of different approaches (phylogenetic, palaeontological, geochemical) which provide incomplete yet complementary perspectives. My presentation will focus on our general approach and in particular the need to consider large scale biological and geochemical processes together. Several lines of evidence demonstrate that symbiosis between fungi and diverse photobionts (e.g., plants, algae, cyanobacteria) was widespread in life on land from the outset. This relationship was particular important during the early evolution of plants, which underwent what is arguably the most spectacular of all diversifications, beginning with the formation of their fundamental organs and tissue systems during the early phases of land colonization. Fungi were crucial, enabling plants to scavenge essential elements from the environment in usable form (e.g., nitrogen, phosphorous) and receiving carbohydrates as their reward. As the symbiosis developed, it drove environmental change on a large scale with further major consequences for the evolution of plants.

Kingma, Elselijn (University of Southampton, UK)

Metaphysics of Pregnancy: the relationship between the fetus and the maternal organism.

One very striking form of biological interdependence is that occurring in mammalian pregnancy: the relation between the fetus and the maternal organism. This relationship has not received much philosophical attention, which is an oversight I shall try to remedy in this paper.

I first reject one popular view of this relationship – the fetal container model – according to which the fetus is not part of but merely contained within or surrounded by the gestating organism. I then compare two other views of this relationship. One is the part-whole model, according to which the fetus is part of its gestator. The alternative view draws upon other forms of biological cooperation and interdependence, such as symbiosis. What sets pregnancy aside from other forms of symbiosis, is that the cooperation is between entities that belong to the same species – indeed the very same lineage. This raises questions whether symbiosis is the right model to apply here, and whether and where firm lines can be drawn between generations. I also question whether pregnancy is substantially different from other forms of intergenerational cooperation or parent-offspring transfer of resources, such as lactation, nurturing and niche construction.

Koutroufinis, Spyridon (Berlin Institute of Technology, DE)

Dynamical Depth – A Processual View of Complexity

The creation of a process ontology for biology that explicitly refutes all versions of both mechanistic and substantialist thought is one of the most ambitious and important projects of current philosophy of biology. However, the term *process* is mostly not clearly defined in current debates. In this paper I provide a definition of 'process' based on an abstract understanding of organismic dynamics. I argue that the main methods of modeling used in systems biology rest upon the assumption that organisms are self-organized dynamic systems. By introducing a distinction between intrinsic and extrinsic causal factors I demonstrate that organisms and self-organized systems obey two different logics of causality and suggest an organism-centered concept of process.

I argue that a critical difference distinguishing linear and self-organized systems from organisms is a difference in dynamical organization that is not well accounted for by current concepts of *complexity*. I introduce a measure of the complexity of a system that is largely orthogonal to computational, information theoretic, or thermodynamic conceptions of structural complexity. What Terrence Deacon and I call a system's *dynamical depth* is a separate dimension of system complexity that measures the degree to which it exhibits discrete levels of nonlinear dynamical organization in which successive levels are distinguished by the generation of intrinsic causal factors. A system with greater dynamical depth than another consists of a greater number of such nested dynamical levels. Thus, a mechanical or linear thermodynamic system has less dynamical depth than an inorganic self-organized system, which has less dynamical depth than a living system. Including an assessment of dynamical depth can provide a more precise and systematic account of the fundamental difference between inorganic systems (low dynamical depth) and living systems (high dynamical depth), irrespective of the number of their parts and the causal relations between them. I conclude by distinguishing different levels of dynamical depth of *symbiosis*.

Meincke, Anne Sophie (University of Exeter, UK)

One or Many? On the Composition of Organisms

Within metaphysical discussions on the constitution of material objects, organisms have gained some special attention since Peter van Inwagen's famous claim that they are in fact the only existing complex material objects in the world. According to van Inwagen, the answer to the so-called Special Composition Question 'When do some things compose something?' is 'If their activity constitutes a life'. From this it follows that every material object is either a mereological atom or a living thing. Strictly speaking, there are no tables, cars, rocks and planets; there are only elementary particles on the one hand and cactuses, jellyfish, dogs and humans on the other.

Surprisingly, this radical claim has not led to any sufficiently elaborate theory of the composition of organisms so far. Though van Inwagen admits that fulfilling this task is ultimately the business of biology, the positive arguments he gives for his central claim mainly appeal to a fairly diffuse notion of life borrowed from the 17th-century philosopher John Locke. The core idea is that life in the biological sense (as opposed, e.g., to the 'life' of a star) endows certain arrangements of particles with a significantly stronger unity so as to make them compose something. While table- or rockwise arranged particles do not compose anything but stay ontologically what they are, namely *many* particles, cactus- or dogwise arranged particles, it is argued, form a new individual, namely *one* organism.

In my talk I shall critically analyse this notion of living unity. My main criticism will be that van Inwagen's case for the existence of organisms relies on a rather disharmonic combination between two things each inappropriate already in itself: an atomistic approach to the constitution of material objects regardless whether they be physical or biological on the one hand and a somewhat naïve Aristotelian concept of an organism on the other. This combination creates a serious obstacle to developing a convincing understanding of the organisational principles at work in the composition of organisms. I will conclude with an outline of how to overcome this obstacle as well as with an indication of where the real challenges and tasks lie for a metaphysical theory of organismic composition that rightly may call itself being biologically informed. It is here that symbiosis comes into the picture.

Paszkowski, Uta (University of Cambridge, UK)

Rhizosphere Communication in Fungal Symbioses of Cereals

The rhizosphere ubiquitously contains a plethora of chemical signals that originate from a wide variety of organisms. Detection and discrimination of these signals is crucial to launch the appropriate partner responses resulting in attraction and association. Distinguishing host from non-host or beneficial from parasitic microbe may be vital for survival. In beneficial interactions, such as the life-long alliance of arbuscular mycorrhizal fungi with plants, pre-symbiotic mutual recognition is manifested in a well-orchestrated exchange of signals. The nature of some of the signals has been discovered in recent years, providing a first insight into the type of chemical language spoken between the two symbiotic partners. Importantly, these discoveries suggest that the dialogue is complex and that additional factors and corresponding receptors remain to be unveiled. I will introduce two fundamentally new concepts for "speaking" and "listening" of plants during rhizosphere communication with beneficial soil-borne fungi.

Pradeu, Thomas (University of Bordeaux, FR)

Host-symbionts interactions in the development of organisms across phyla: Ecosystemic individuality and the unifying role of the immune system.

The scientific understanding of development currently undergoes an important conceptual, experimental, and technological revolution. In the last fifteen years, new data, often based on recent technological tools, made it clear that the normal development of organisms is massively dependent on host-symbionts interactions. In organisms as diverse as plants, sponges, cnidarians, arthropods, or mammals, the construction of an organism, indeed sometimes the very first steps of this construction, necessitates the presence and action of bacterial or viral symbionts. Developmental symbioses, long thought to be rather rare, now appear to be ubiquitous in nature (Gilbert and Epel 2015; Nyholm and McFall-Ngai 2014). Organisms are "holobionts" (that is, host-symbionts units), and are built "holobiontically," in the sense that symbionts are necessary for the normal construction of an organism.
In this talk, I will try to characterize this scientific revolution, and I will emphasize its deep conceptual consequences for our understanding of biological individuality. I will make four main claims:

- Taking into account developmental symbioses impacts significantly our understanding of development;
- Taking into account developmental symbioses impacts significantly our understanding of biological individuality;
- Even though organisms are ecosystems, they are very particular ecosystems as they exhibit an extremely strong degree of unity;
- Across phyla, the immune system plays a decisive role in the unification of the heterogeneous constituents of the organism.

I will conclude by defending a "multidisciplinary" approach to biological individuality, based on the joint lessons of evolution, development, ecology, microbiology, and immunology.

Rigaud, Thierry (University of Bourgogne, FR)

What is an "individual" characteristics? Lessons from selected natural histories in some symbiotic systems.

Since the discovery of the prokaryotic origin of mitochondria, there are accumulating evidences that the supposed-to-be biological individuals are in fact the result of accumulations of successive interactions between evolving entities. I'll illustrate this point using few examples of symbiotic systems. I shall first describe how some eukaryotic "organisms" (insects, crustaceans) see some of their critical life history traits (a part of their immunity, reproduction, sex-determination) passing under the complete control of endocellular symbionts (microorganisms). Links between the hosts and symbionts sometimes became so intimate that defining where are the "individual" boundaries is almost impossible. I shall then describe how some eukaryotic parasites can alter the behaviour of their hosts, providing further examples of "individual" phenotypes resulting of several organisms (genomes) in interaction.
Some of these systems appear stable, but most of them are probably not, because of the constant co-evolution (arm race?) between the interacting partners…

Practical Information:

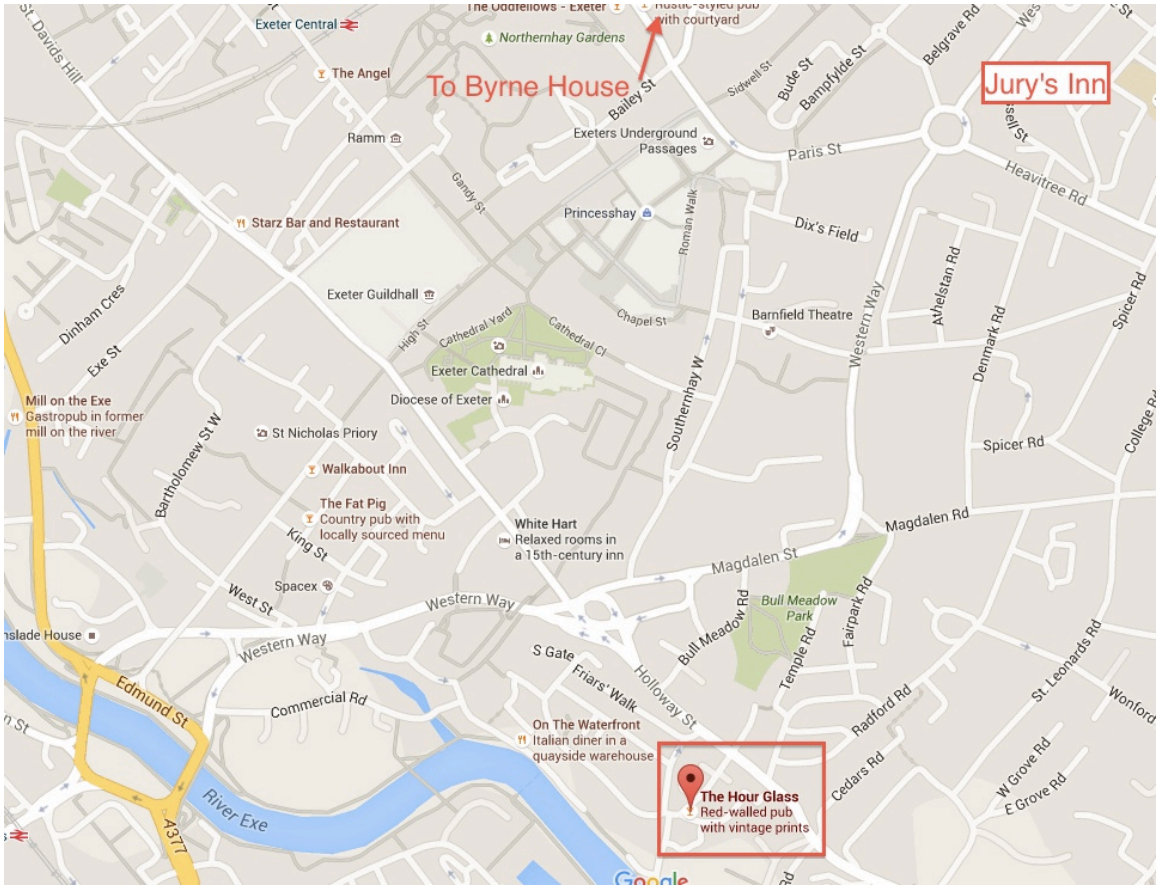
Conference Dinner:

The conference dinner will take place from 7:30pm on Thursday 19 November at The Hourglass pub (http://www.hourglassexeter.co.uk) in Exeter.

The pub is about a 25 mins walk away from Byrne House (or a 10 min drive (according to Google Maps)).

Address:
The Hourglass
21 Melbourne St
Exeter
EX2 4AU

Map of Exeter town centre:



Streatham Campus Map:

Byrne House is located on the Streatham campus of University of Exeter.

ATM machines are located in the Forum (indicated on the map as 'Main Library' building).