July 1st-5th 2019 – Hotel BW Karitza, Biarritz, France

ERC IDEM Summer School
Microbiota, Symbiosis, and Individuality

Program

Monday, July 1st 2019

12:00 pm	Arrival of participants
1:00 pm - 2:30 pm	Lunch
2:30 pm - 3:45 pm	Welcome session Presentations: *2 slides, 2 minutes* (1 slide *who am I*, 1 slide *what is my problem with Microbiota & Individuality*)
3:45 pm - 4:45 pm	Microbiota: conceptual analysis *Host: Thomas Pradeu*
4:45 pm - 5:15 pm	Break
5:15 pm - 6:45 pm	Scott Gilbert **Expanding Evo-Devo: Developmental symbiosis as a mechanism for opening new evolutionary trajectories**
6:45 pm - 7:45 pm	Apéro and group setup
7:30 pm	Dinner

Tuesday, July 2nd 2019

9:00 am - 10:00 am	Individuality: conceptual analysis *Host: Johannes Martens*
10:00 am - 10:15 am	Break
10:15 am - 11:45 am	Thomas Pradeu **Interactions between the microbiota and the immune system: An immunological point of view on biological individuality**
11:45 am - 12:00 pm	Break
12:00 pm - 1:00 pm	Article discussion session 1 One group per course leader
1:00 pm - 3:00 pm	Lunch
3:00 pm - 4h30 pm	Jan Pieter Konsman **Barriers and obstacles in relation to microbiota's distant host effects**
4:30 pm -5:00 pm	Break
5:00 pm -7:00 pm	Speed dating 1 *(10 min / person)* Group work 1
7:30 pm	Dinner

Wednesday, July 3rd 2019

9:00 am - 10:30 am	Johannes Martens **Fraternal vs. egalitarian transitions in individuality:** **Two processes, one concept?**
10:30 am - 10:45 am	Break
10:45 am -12:45 pm	Speed dating 2 Group work 2

1:00 pm - 3:00 pm	Lunch
3:00 pm - 4:00 pm	Article discussion session 2
4:00 pm - 6:00 pm	Group work (prepare presentation and final document – 2 pages) Participants have to define a point of view which they need to defend later
6:00 pm	Pétanque and other outdoor activities
7:30 pm	Dinner

Thursday, July 4th 2019

9:00 am - 10:30 am	Video-conference with Thomas Bosch **The Holobiont Imperative:** **Towards an holistic understanding of complex life processes**
10:30 am - 10:45 am	Break
10:45 am - 11:45 am	Preparation rebuttal with course leader
11:45 am - 12:45 pm	Results group 1 *30 minutes presentation, 10 minutes rebuttal, 20 minutes discussion*
1:00 pm - 3:00 pm	Lunch
3:00 pm - 6:00 pm	Results group 2, 3, and 4
6:00 pm - 7:00 pm	Optional seminar: *How to write an interdisciplinary article*
7:30 pm	Dinner

Friday, July 5th 2019

9:00 am - 10:30 am	Rob Knight **The role of microbes in shaping traits that define who we are physically and mentally**
10:30 am - 10:45 pm	Break
10:45 am - 12:45 pm	Speed dating - Rob Knight *(5 min / per person)* Preparation of an article suggested by Rob Knight with Twitter discussion Somewhere in between 15 min break
1:00 pm - 3:00 pm	Lunch
3:00 pm - 4:00 pm	Discussion of the article with Rob Knight
4:00 pm - 5:00 pm	Pre-peer review of the group work results by Rob Knight *Each group presents 5 minutes (20 minutes total)* *Rob Knight has 40 minutes to react*

This summer school has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme - grant agreement n° 637647 – IDEM

Abstracts

Expanding Evo-Devo: Developmental symbiosis as a mechanism for opening new evolutionary trajectories

Scott Gilbert
Swarthmore College, USA

Evolutionary developmental biology has concentrated on the formation of new structures through changes in gene expression. However, whereas the human genome contains some 22,000 genes, it receives over eight million different genes from its microbial symbionts. The differential expression of microbial genes may be critical in producing new anatomical, physiological, and behavioral phenotypes. Moreover, both vertically and horizontally transmitted microbes have been shown to alter development to produce in selectable adaptations. Recent research proposes that microbial symbionts are necessary for the development of particular organs of certain species, for the variation of selectable traits within a species population, and for the emergence of particular social behaviors. This research also suggests that some evolutionary transitions have been facilitated by symbiotic microbes. These transitions include the origins of multicellularity, meiosis, the nervous system, and herbivory, the complex of anatomical, physiological, and behavioral traits allowing animals to eat plants. Herbivory will be discussed from the point of view of holobiont evolutionary developmental biology, wherein specific adaptations (such as the rumen), are seen as being induced by microbes, and the behavioral and physiological manifestations of herbivorous phenotypes need to be preceded by the successful establishment of communities of symbiotic microbes that can digest plant cell walls and detoxify plant poisons.

Interactions between the microbiota and the immune system:

An immunological point of view on biological individuality

Thomas Pradeu
CNRS, University of Bordeaux, France

It has long been thought that the organism is preserved from microorganisms. This was supposed to occur via two main processes. The first is closure: microorganisms are kept outside the organism (for example, in the lumen of the gut). The second is immune protection: microorganisms that enter into the organism are eliminated by the immune system. These two ideas have been central to the development of the self-nonself theory, which has dominated immunology since the 1950s (Burnet 1962).

Yet research done in the last fifteen years has invalidated these two ideas (Belkaid and Hand 2014). First, the organism constantly interacts with microorganisms at bodily interfaces, especially via its immune system. Second, in most cases, the immune system tolerates, rather than eliminates, the microorganisms with which it interacts. Third, there is a co-construction between the immune system and the microbiota. Fourth, the dialogue between the immune system and some components of the microbiota contributes to the realization of major physiological activities.

In this lecture, we will explore in detail immune-microbiota interactions, and examine how they impact our understanding of health and disease as well as our concept of biological individuality (Pradeu 2012).

References

Belkaid Y, Hand TW (2014) Role of the microbiota in immunity and inflammation. Cell 157:121–141. doi: 10.1016/j.cell.2014.03.011

Burnet FM (1962) The Integrity of the Body: A Discussion of Modern Immunological Ideas. Harvard University Press, Cambridge, MA

Pradeu T (2012) The Limits of the Self: Immunology and Biological Identity. Oxford University Press, Paperback 2018, New York

Barriers and obstacles in relation to microbiota's distant host effects

Jan Pieter Konsman
Institute for Cognitive and Integrative Neuroscience (INCIA),
University of Bordeaux, France

Organisms are bounded. Boundaries do not simply mark the edges of the organism's spatial extension, but are also interfaces through which selective exchange with the environment occur that enable an organism to maintain its existence. In addition to the interfacing boundaries between the organism and the exterior world, there are also internal "barriers" that separate organelles from the cytoplasm and organs from systemic circulation (e.g., the blood-brain barrier) or enclose internalized "environments" or cavities (e.g., the gastrointestinal barrier). The gut lumen's internalized environment contains an important microbiota community. The presence of microbiota in internalized environments raises the general questions of how microbiota interact with local host barriers, for example the gastrointestinal barrier enclosing the internalized microbiota environment, and if microbiota interact with or influence more distant organ barriers, such as the blood-brain barrier. Here I will mostly address the latter question as there have been numerous recent claims according to which the gut microbiota influences or determines brain function and behavior. I will first introduce the notion of biological barriers and discuss their regulation. Next, I will present some of the claims that have been made about gut microbiota's effects on brain and behavior. Finally, I will discuss 1) some 'epistemic obstacles' can occur concerning terms, such as barrier and endotoxin and address how 2) concepts like the 'microbiota-gut-brain axis' may wrongly suggest unique structural organization 3) whereas systems biology approaches involving gut microbiota may not sufficiently take into account biological organization.

Fraternal vs. egalitarian transitions in individuality

Two processes, one concept?

Johannes Martens
Catholic University of Louvain, Belgium

In the biological literature, a "major transition in individuality" refers to the process by which a new population of biological individuals emerges from a population of entities that were previously able to undergo natural selection. During this process, the lower level entities loose their status as units of selection, and become parts of the higher level individuals (Buss 1987; Michod 1999).

Two sorts of transition are usually distinguished by evolutionary biologists, namely fraternal and egalitarian transitions (Queller 1997). In a fraternal transition, genetical relatedness plays a key role in the "transfer" of individuality from the lower level to the higher level, whereas in an egalitarian transition, the "transfer" depends on the complementarity of the partners, and on the existence of a common reproductive fate between them. The evolution of multicellular organisms is often cited as a paradigmatic instance of fraternal transition, while some symbiotic alliances – such as the eukaryote cell (which resulted from the integration of two or more prokaryotes) – are commonly regarded as bona fide outcomes of egalitarian transitions.

In the biological and philosophical literature, the term "major transition in individuality" is equally applied to describe fraternal and egalitarian events. Yet, significant differences exist between the kinds of organisation that have emerged from these evolutionary processes. In this seminar, our goal will be to shed light on the nature of these differences, and to see whether the same notion of biological individuality can be used to account for the higher level outcomes of both fraternal and egalitarian transitions. We will further envisage some of the main implications/limits of a general evolutionary approach for our current understanding of endosymbioses.

The Holobiont Imperative:

Towards an holistic understanding of complex life processes

Thomas C. G. Bosch
University of Kiel, Germany

In the last decade, biology has made revolutionary advances from century-old debates about the relative importance of non-pathogenic bacteria. Today we know that individuals are not solitary, homogenous entities but consist of complex communities of many species that likely evolved during a billion years of coexistence. Holobionts (hosts and their microbes) and hologenomes (all genomes of the holobiont) are multipartite entities that result from ecological, evolutionary and genetic processes. I propose, therefore, that the health of animals, including humans, is fundamental multi-organismal; and that any disturbance within the complex community of host and microbial cells has drastic consequences for the wellbeing of the individual member of this association. This newfound awareness of the dependency of phenotypes on other species and environmental conditions presents additional layers of complexity for the life sciences including medicine and evolutionary theory; and raises many questions that are being addressed by new research programs.

The role of microbes in shaping traits

that define who we are physically and mentally

Rob Knight
University of California San Diego, USA

There are lots of concepts of "human gene", not always compatible with each other. These all assume the gene is in the germline. However, the vast majority of genes associated with our bodies are in our microbiomes, not in our germline. We're just discovering the large impact these have on phenotype. And unlike our germline genes, which are fixed at conception, we can consciously change them.

These microbial genes alter our response to drugs, to food, our weight, and even our mood, getting at very core traits that differentiate individuals. Just as a human germline gene can be transferred to mice to affect their phenotypes, so can the genes from the human microbiome. This has been shown to transfer obesity, inflammatory bowel disease, parkinson's, multiple sclerosis, major depressive disorder, and most recently autism (or at least symptoms resembling these conditions).

The amount of variance in many traits is better explained by microbial genes than by human genes. Working out the causal pathways is hard and still in progress. If human genes are "context-sensitive difference makers", the same has been shown to be true of microbial genes. Understanding microbial genes or microbial communities as a unit of evolution is still a messy unsolved problem, with potentially interesting philosophical work to be done. Developmental Systems Theory provides a framework for understanding relationships to our microbiomes as reliable relationships to a resource.

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