

Questioning the Tree of Life Network



Report on the sessions held at the Philosophy of Science Association biennial meeting, Pittsburgh, November 6-9, 2008

The first formal event engaging members of the Questioning the Tree of Life Network took place at the biennial meeting of the Philosophy of Science Association (PSA), held between November 6th and 9th in Pittsburgh. The Network was awarded two sessions by the PSA Programme Committee and these took place on November 7th.

The first session featured talks from Network members and the second was devoted largely to discussion. A large audience of over 100 PSA and History of Science Society (HSS) members attended the first session and about half of them came back for the discussion. We have been given considerable positive feedback about the sessions and the topic in general, and the Network members who participated in the sessions found them valuable for both the discussion and the connections they made with philosophers outside the Network. Overall, those of us involved in this event consider it to have been highly successful.

A large range of topics were covered by the presentations, and these led to a number of questions being raised by the audience and discussed further in the second session.

Presentation synopses

Richard Burian (Virginia Tech) opened the session with an introduction to the topic of the Tree of Life and Maureen O'Malley (Exeter) outlined the Network project very briefly with a handout pointing to the project webpage.
<http://centres.exeter.ac.uk/eGenesis/research/QuestioningtheTreeofLife.htm>

The first presentation was given by Bill Martin (Heinrich-Heine Universität, Düsseldorf), and addressed the theme of *Endosymbiosis, the Tree of Life, and genomes (the good, the bad, and the ugly in evolution)*. After a historical introduction to phylogeny and endosymbiosis, Bill discussed the evolutionary implications of lateral gene transfer (LGT) and endosymbiosis. His slideshow concluded with a dramatic representation of how lateral processes overwhelm any (presupposed) vertical backbone to a universal evolutionary tree.

Eric Baptiste (UPMC, Paris) followed, with an account of *Problems with traditional phylogenetic analysis: pluralistic phylogeny as an alternative*. Building on the argument he made with Ford Doolittle in *PNAS* in 2006, Eric argued that the assumption that the unique universal tree is a fact has pervaded phylogeny. He demonstrated repeatedly how LGT undermines any

such assumption and makes saving the one true tree an impossibility, no matter what approach or conceptualization is attempted. He concluded with a call for a better, more pluralistic description of the history of biodiversity than a single tree can provide.

Yan Boucher (MIT) covered a theme entitled *The variation of evolutionary processes across microbial diversity*. He examined how diversity-generating processes vary remarkably across microbial lineages, whether these are mutation rates or recombination rates, and that the relationship of mutation to recombination also varies extensively in lineage comparisons. Yan argued that a much more pluralistic understanding of evolutionary processes would result in an equally pluralistic understanding of units of evolution, and that the evolutionary dynamics of any potential 'species' had to be investigated in association with any such designation.

Jeffrey Lawrence (Pittsburgh), in his talk entitled *Order from chaos in bacterial evolution* (and a subsequent elaboration), gave an outline of the way in which bacterial recombination can yield a misleading appearance of hierarchical evolutionary order. If geological time is conflated with generational time, fundamentally different processes in prokaryotes can be deemed to give rise to hierarchical patterns similar to those exhibited by eukaryote evolution. He illustrated his argument with data showing how architecture-imparting sequences (AIMS) mediate a bias in phylogenetic reticulation that 'masquerades' as hierarchy. Prokaryote groups cohere because of gene exchange but this occurs gene by gene, not by recombination of genomes. Patterns of gene exchange in prokaryotes are not indicative of common ancestry, but are frequently interpreted as if they are. Lineages are not distinct because they are still exchanging genes at different loci. A single tree, therefore, can only be a misattribution.

In his discussion of *Do charismatic eukaryotes live in trees?*, John Dupré (Exeter) suggested that the general argument against phylogenetic trees could very likely be extended to eukaryotes. He briefly discussed the growing evidence for the prevalence of interspecific hybridisation and then considered the impact of viruses on eukaryote genomes generally and the human genome in particular, specifically outlining recent hypotheses about the role of endogenous viral genes in the development of the placenta. Viral insertions of this kind can be seen as a form of endosymbiosis, and suggest the importance of lateral processes on evolution in general. Such processes cannot be adequately represented by a unique tree-like structure.

Rob Wilson (Alberta) talked about the strong thesis of *How the microbial world ruins everything*. He urged caution in radical deconstructions of phylogeny, and outlined the range of responses that findings of lateral gene transfer and endosymbiosis could invoke: the elimination of a single tree of life, the exceptionalist treatment of microbial phylogeny, and pluralistic approaches to tree construction. He suggested that a conflation of methodological pluralism and ontological pluralism had occurred, and that instead of elimination of the tree, a richer modified version could be sufficient.

Marc Ereshefsky (Calgary) gave an account of *Microbes and species* that outlined the problems in applying eukaryote species concepts to the prokaryote world. He pointed out that because the majority of life now and throughout evolutionary history has been and is microbial, no universal species concept can cover all life. Species, therefore, exist only as pragmatically defined categories and not as anything essentially real.

In her discussion of *Which trees need questioning?*, Laura Franklin-Hall (NYU) challenged attempts to save the universal tree, specifically as a core gene tree. She urged the audience to evaluate a tree that tracked cellular evolution and concluded that she could see no explanatory or other value in a tree that cuts across all existing ways of grouping according to physiological and genetic properties.

The final speaker for the presentation session, Joel Velasco (Stanford), discussed *What species trees cannot be*. After distinguishing between a species tree and an organism tree, Joel argued that genealogical connections between groups form a Tree that is metaphysically prior to any conception of how to group them. He concluded that both gene trees and organism trees are ineliminably important for biology, but that species trees can be discounted unless they are one of the former.

The second session began with a summary by Elliott Sober (Wisconsin) of the previous talks and their implications. He addressed the general tree of life hypothesis and identified three formulations it might have: a strong one, of no reticulation at all; a more moderate one, for which a tree is a major pattern in the structure of life but not a synonym for genealogy; and the most modest formulation, in which a tree is a highly variable pattern (from lots of transfer to a little transfer) that is called a tree just because it is rooted in a common ancestor. Different ideas of what the tree is may depend on perspective. Zoom in and there is a lot of reticulation; zoom out and there's a tree again. The richest philosophical questions in Tree of Life studies, Elliott concluded, are to do with reductionism, emergence and relationships at different levels. The metaphysics of composite objects (e.g., Derek Parfit) may be relevant to future discussion of such issues. And we should think further about species. For example, do species supervene on components or is the relationship a stronger one than supervenience? What do we want our species concepts to do for us? Is a species concept only biologically useful if it applies to all living things? Are species just at the tips of trees? These are just instances of the stimulating questions to which Tree of Life studies can lead.

Discussion synopsis

Questions from the audience were directed towards individual speakers and the panel as a whole. The issues raised fell into several broad categories within which questions were often repeated in slightly different forms. Although panel members answered all the questions and discussed them more generally, only the questions are listed in order to preserve the focus on what the issues were for the audience.

Eukaryotes versus prokaryotes

- But there's not a problem for the eukaryote tree of life, surely?
- Isn't the stable reproduction of eukaryote lineages sufficient to ignore all lateral processes?
- Is phylogeny a problem everywhere, regardless of the domain?
- Do we need to think about a greater variety of evolutionary processes for eukaryotes too?
- Does the idea of composite lineages, such as humans being partly constituted by all kinds of microbes (intra- and extragenomically), mess up the tree everywhere?

Ontology versus epistemology of trees

- What does it mean to say 'there is no tree'? Is this really an epistemological claim masquerading as an ontological one?
- How can the existence of a tree be asserted if the tree cannot be constructed?
- Do trees have emergent properties and is the problem one of trying to construct them mechanistically?

Constructing trees

- Do trees only appear because of using tree programmes to make them?
- What else could be done to capture evolutionary processes?
- Why aren't network representations more popular?

Species and classification

- What about the 16S gene? Doesn't it capture the evolutionary essence of organismal lineages?
- Natural groups and operationalizations of species aren't opposed, are they? The homeostatic property cluster (HPC) concept of species captures natural patterns of clustering in a non-arbitrary way, so what's the problem?
- Are there more evolutionary units than species and what do we call them?

Future network plans

The network's activities at the PSA concluded with a dinner meeting to discuss future plans. Several suggestions were made and general agreement reached to proceed on all of them.

1. Website

Develop a more interactive website, with more information about activities, members, research themes and so on. Provide links to relevant papers published by Network members and non-members.

Follow-up: Maureen, John, Saira Kidangan (Tree of Life Network Co-ordinator)

2. SMBE session

Hold a satellite tree of life philosophy session at the Society for Molecular Biology and Evolution (SMBE) meeting in Lyon, 2010. Bill Martin will be able to contribute some funding towards 5-6 Network members participating in this event.

Follow-up: Bill, Maureen, Saira

3. ISHPSSB session

Offer a session on Tree of Life issues at the International Society for History, Philosophy and Social Studies of Biology (ISHPSSB), Brisbane, July 2009.

This is an important professional meeting for many philosophers of biology, and at least some of us already plan to attend.

Follow-up: Maureen, Rob

4. Halifax workshop plans (July 29th-Aug1st, 2009)

Pair philosophers and biologists on specific issues. Set up a tentative programme in early 2009 and suggest it to all participants. Ideally, we will all be bringing proto-papers to that meeting so that they can be revised for publication in *Biology and Philosophy* in early 2010 (see the next item).

Follow-up: Maureen, John, Saira

5. Publications

a) *Biology and Philosophy* special issue.

We need to be thinking of our papers for the workshop and special issue now. These can be collaborative and individual papers and can address diverse themes to do with the tree of life. For example, Lisa Gannett, a Network member based at St Mary's University in Halifax, will contribute a paper on issues to do with constructing trees of human ethnic groups.

Follow-up: Everyone, with frequent reminders in 2009 from Maureen and Saira

b) Edited book.

Rob Wilson and Kim Sterelny are editors of a book series that may be appropriate for publishing a set of papers on the Tree of Life.

Follow-up: Rob, Kim, Maureen

6. Collaboration visits

The project has some money for visits between potential collaborators. Eric, Yan and Marc (possibly Laura as well) have begun some work together and may meet in a convenient location to make collaboration easier.

Follow-up: Maureen (to facilitate); everyone else to think of collaborations

7. Other activities

- Two more people joined the Network after PSA: Olivier Rieppel, a phylogeneticist at the Field Museum in Chicago, and Greg Morgan, a philosopher at Spring Hill, Alabama. You will be able to link to their work via the Network website.
- Eric is co-ordinating a collaborative paper between biologists and philosophers for *Biology Direct*. The paper will be finished sometime in early 2009.
- John has done an interview on the Tree of Life, referring to the Network, with a journalist from the *New Scientist* (December, 2008).
- Marc Ereshefsky is giving a talk in January 2009 at the Calgary Science Museum on 'Darwin's Tree of Life'.
- Several Network members will participate in a DarwinFest at Dalhousie University, October 2009. There will be a session on the Tree of Life.