

#3

**Manfred D. Laubichler: Research and Teaching Statement**

— Nothing has such power to broaden the mind as the ability to investigate systematically and truly all that comes under your observation in life. (Marcus Aurelius)

All my research is multi- and interdisciplinary, by design and because it cannot be accomplished otherwise. My research is focused on conceptual problems of biology, their history, and their theoretical analysis, especially in the context of evolutionary developmental biology (Evo Devo). Specifically, my driving research questions and interests are: the conceptual basis and theoretical structure of biology—what are its elements, fundamental concepts, and theoretical models? How is biology related to other sciences and what is the place of biology within a theoretical system of the sciences and of scientific explanations? How is biology embedded within available technological, scientific, economic, and societal contexts and how are these various resources integrated into the conceptual structure of biology? What enables the synthesis and integration of different data and models into coherent explanations of biological phenomena? To address these more abstract questions, I am focusing on a few case studies such as evolutionary developmental biology, developmental biology/embryology, and theoretical biology.

I am addressing these questions from two scholarly angles, as a theoretical biologist and as a historian of biology. This reflects my conviction that understanding one requires an equally detailed understanding of the other. The common problem behind all my questions is the issue of integration; integration of different types of data within a theory or model, integration of different experimental and theoretical approaches within a synthesis, such as Evo Devo, and the integration of different layers of context (technological, scientific, societal, legal, and so on) within an understanding of science in society, both throughout history and in the present. My fundamental assumption is that history matters and that the history of biology is an important resource for current science, especially those areas that focus on theoretical and conceptual integration. History reveals the constraints and hidden assumptions of the theoretical structures of different areas of science, it demonstrates the multiple ways science and scientific theories are embedded in multiple contexts, both scientific and societal. If the scientific goal is to integrate different approaches, knowledge of the varied histories of these traditions, their concepts and experimental models is thus essential. My second fundamental assumption is that science matters and that it is not particularly interesting (at least to me) to write the history of science without a detailed understanding and reconstruction of scientific problems. This dialectical relationship between science and history also extends to questions of science in society. If the goal is to shape the future direction of science (whether advocating a particular research program or making science policy) or to comment on current affairs, it is essential to understand the multiple interactions between science and society from a historical perspective. Again, history will contribute to our understanding of both the limits and the possibilities of science.

Here I will briefly sketch my scientific biography, current and future research projects and interests and their integration, editorial activities, and collaborations.

**(1) *Scientific Biography:*** My research experience reflects my interdisciplinary interests. I was originally trained as a zoologist, working on theoretical and mathematical problems of evolutionary theory. I obtained a M.Sc. in Zoology from the University of Vienna and a Ph.D. from Yale University. While I continued to work on theoretical problems, especially those related to the problem of epistasis and epigenetic effects, I was accepted into the Ph.D.

program in History/History of Science at Princeton University. I received my M.A in History and am about to defend my second Ph.D. (The thesis is written, but my teaching and research obligations at ASU have delayed scheduling the actual defense. Schedules permitting I plan to schedule it late this fall, after I am done teaching for the semester)<sup>1</sup>. My expertise thus includes, mathematical biology, evolutionary developmental biology, the study of complex systems, history and philosophy of science, and cultural history. Since coming to ASU I have also been involved in questions of biology and society. Throughout my career I have been connected to both US and European institutions. I therefore see my career as one “in translation,” between different academic and scientific cultures and between different disciplines.

**(2) Ongoing and Future Research —History of Biology:**

(a) History of Evolutionary Developmental Biology: Here my goal is to explore the history of the interactions between developmental biology/embryology and evolutionary biology. This is a fascinating history that involves a lot of conceptual and technological issues as well as cultural factors that can still be seen in different national traditions within Evo Devo. I have so far co-edited a volume on this topic (with MIT Press) and started a series of vignettes in the History of Evo Devo in the Journal of Experimental Zoology.

(b) The Embryo Project: The Embryo Project is a large interdisciplinary research project I co-direct with Jane Maienschein. It aims to understand embryo research (classical embryology and modern developmental biology) as a case study of rapidly changing science within radically contested contexts. As with any science, embryo research is embedded in webs of unsettled ethical, legal, political, religious, cultural, and social negotiations that shape the conduct of science, its diverse meanings, and the spectrum of decisions built upon such understandings. Embryo research starts with a scientific drive to understand development of the individual organism and is shaped by three clusters of factors: (1) technical, including experimental techniques, equipment, and the way results are presented (in publications and presentations) and represented (in images and models); (2) actors, laboratory settings, institutions, and local contexts of scientific and technical work; and (3) social/cultural/intellectual/economic environments in which the work is done. The factors combine to serve as *agents of change* shaping *science in society*. The project will lead to an online database developed in collaboration with the Max Planck Institute for the History of Science, educational materials, and scholarly publications.

(c) History of Theoretical Biology: My work in the History of Theoretical Biology aims at integrating a detailed analysis of the content of science with its cultural and social influences, also connecting this history with epistemological questions such as the role of the concept of “the general” (*Das Allgemeine*) in the sciences of the 19<sup>th</sup> and 20<sup>th</sup> century. I see this work as contributing to a richer understanding of the conceptual development of science that is simultaneously embedded within a complex web of cultural and social interactions. I find recent developments in cultural history of science and sociology of science extremely helpful and I want to develop a framework that allows me to combine these ideas with technical and epistemological questions of the sciences. I have been approached by Sam Elworthy, Editor of Princeton University Press, about a monograph on the History of Theoretical Biology. This will be a main focus of my research and writing during the next two years.

---

<sup>1</sup> This Fall I again teach a double load, Bio 311 (Biology and Society) and Bio 431 (Genes, Development, and Evolution) for the Learning Community. In addition, I teach the first two weeks of Bio 351 (Developmental Anatomy). Travel possibilities in the beginning of the semester are thus limited.

**(3) Ongoing and Future Research—Theoretical Biology**

(a) Conceptual and Theoretical Problems in Evolutionary Developmental Biology: In Evo Devo my work centers on theoretical and conceptual issues. I am working on mathematical models of epistatic and epigenetic effects, the problems of evolutionary innovation, and the character and homology concepts. Another problem is the relationship between Form and Function in Evo Devo. A volume on this topic is under contract with Cambridge University Press.

(b) Social Insects as a Model System for Evolutionary Developmental Biology: One of the important problems in science is the question of finding the right model system for a particular problem. Social Insects have many advantages for Evo Devo questions. Together with a network of collaborators, some of the leading Social Insect researchers, I am developing a work program for Social Insects as a Model System for Evo Devo. It will allow us to specifically address the question of how morphological and behavioral novelties emerge in evolution. This has the potential to grow into a substantial international research program. I have been invited to lead a working group on this topic at the Wissenschaftskolleg (Institute for Advanced Studies) in Berlin 2008/09.

(c) Modeling Biology: Mathematical and Computational Models are an important part of Theoretical Biology. They also serve as a locus of conceptual integration and innovation. I am interested in (1) understanding the role of modeling in theoretical biology, especially how models relate to theory formation and (2) developing agent based models for developing systems. The latter is a collaboration with colleagues in the Center for Social Dynamics and Complexity, while the former has already resulted in a co-edited volume on Modeling Biology (MIT Press).

(4) **Biology and Society**: In Biology and Society my work has been focused on developing an analytical framework for addressing their multiple relations. I have been teaching a course “Biology and Society” for five years and have established methods of teaching both the science and its social context and ramifications. At several occasions I have also written about issues and controversies for a more general audience (for example, two essays in the Science in Society series of *Science* and essays in the *Frankfurter Allgemeine*). In the future I plan to be more vocal about such issues.

(5) **Integration of Research Questions**: A question might be raised about how all these different projects fit together to form one coherent research program. I address this issue here. As I have outlined above, I see biology, history, and society connected through a web of multiple dialectical relationships, each informing and transforming the other. In this sense all my projects build upon and feed into each other. The conceptual and theoretical work in Evo Devo, the Social Insect work, and the Modeling projects are all informed by the History of Theoretical and Developmental Biology as well as help refine my historical questions and sensibilities. In the same way they are also part of the Embryo Project—as one important trajectory within the history of developmental biology/embryology—and benefit from the interaction with other members and questions within this project. My whole research project can thus be seen as a multi-layered set of questions each connected to all the others and embedded within different contexts: of Evo Devo, Theoretical Biology, History and Philosophy of Biology, and Biology and Society.

(5) **Editorships**: Successful interdisciplinary work depends on collaboration between researchers from different disciplinary backgrounds. One of the challenges in this context is to find a common language. In order to foster the kind of interdisciplinary work in theoretical biology and the history of biology I co-founded a new journal, *Biological Theory*, published by MIT Press. This journal is devoted to the integration of development, evolution and cognition and has a substantial interest in history and philosophy of science. The first issue

appeared in early 2006 and the next are already in press. I serve as an Associate Editor of this journal. I am an Associate Editor of the *Journal of Experimental Zoology, Part B: Molecular and Developmental Evolution*. My responsibilities include Theory and the Series of Historical Vignettes in *Evo Devo* (which I stated in 2003). I also serve at the editorial and advisory boards of two journals in the history of biology (*Journal of The History of Biology and History and Philosophy of the Life Sciences*).

**(6) Research Collaborations:** Due to the interdisciplinary nature of my research projects I have established an extensive network of local, national, and international collaborations. These collaborations have already led to a substantial number of joint projects, papers/volumes, and proposals. For a list of my collaborators see my CV.

### Teaching Philosophy

—The mind is not a vessel to be filled, but a fire to be ignited. (Plutarch)

Teaching at the university level is an enormous responsibility. As Harold Shapiro, former president of both the University of Michigan and of Princeton University as well as former Chairman of the National Bioethics Advisory Commission states in his latest book, “All higher education institutions...serve a public purpose.”<sup>2</sup> He goes on to discuss how scientific and technological progress relates to more traditional ideals of humanism and education. In our complex society, which is defined to a large degree by science and technology, Shapiro points out, a humanistic education is still the foundation of liberal democracy, while proper science education is necessary to face and critically evaluate various technological, environmental, and medical needs and challenges. The interface of science, society, and values is thus an especially important area in undergraduate and graduate education. I have devoted my teaching (and to some degree also my research) to this area. One of the main challenges to teaching science in society is to provide an interdisciplinary perspective. I have prepared myself through graduate studies in biology (Yale) and history (Princeton) for this kind of teaching. Knowledge of different areas is one thing, as Robert Oppenheimer said, “Knowledge rests on knowledge, what is new is meaningful because it departs slightly from what was known before,” but we also have to be able to stimulate our students to think for themselves and make critical connections on their own. I motivate my students with Clarence Darrow’s statement, “To think is to differ,” and Lenin’s recognition that “Learning is never done without errors and defeat.” One of the particular difficulties of teaching science in society is to adequately cover both the details of science and the larger implications of scientific developments. I have found that a historical perspective goes a long way to make this connection not just one of conjecture or personal values (as in the evolution/ID controversy) or gut reactions (as in many problems in bioethics), but allows to establish the complexities of the world at large and also the urgency of the questions. As H.G. Wells put it, “human history becomes more and more a race between education and catastrophe.” Though some of my classes are large, I see teaching mostly as a personal mentorship between student and teacher (with the roles often reversed). I am fortunate that in our Biology and Society programs (UG and Grad, which we established after I arrived here) we have a wonderful group of students, who make teaching at ASU a very gratifying experience.

---

<sup>2</sup> Shapiro, Harold (2005). *A Larger Sense of Purpose: Higher Education and Society*. (Princeton: Princeton University Press).