THE STRATEGY OF LIFE

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THE STRATEGY OF LIFE

*Teleology and Mechanics
in
Nineteenth Century German Biology*

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For Linda

TABLE OF CONTENTS

Preface	ix
Introduction	1
Chapter 1: Vital Materialism	17
Chapter 2: The Concrete Formulation of the Program: From Vital Materialism to Developmental Morphology	54
Chapter 3: Teleomechanism and the Cell Theory	112
Chapter 4: The Functional Morphologists	156
Chapter 5: Worlds in Collision	195
Chapter 6: Teleomechanism and Darwin's Theory	246
Epilogue	276
Notes	281
Name Index	309
Subject Index	313

PREFACE

Teleological thinking has been steadfastly resisted by modern biology. And yet, in nearly every area of research biologists are hard pressed to find language that does not impute purposiveness to living forms. The life of the individual organism, if not life itself, seems to make use of a variety of strategems in achieving its purposes. But in an age when physical models dominate our imagination and when physics itself has become accustomed to uncertainty relations and complementarity, biologists have learned to live with a kind of schizophrenic language, employing terms like 'selfish genes' and 'survival machines' to describe the behavior of organisms *as if* they were somehow purposive yet all the while intending that they are highly complicated mechanisms.

The present study treats a period in the history of the life sciences when the imputation of purposiveness to biological organization was not regarded an embarrassment but rather an accepted fact, and when the principal goal was to reap the benefits of mechanistic explanations by finding a means of incorporating them within the guidelines of a teleological framework. Whereas the history of German biology in the early nineteenth century is usually dismissed as an unfortunate era dominated by arid speculation, the present study aims to reverse that judgment by showing that a consistent, workable program of research was elaborated by a well-connected group of German biologists and that it was based squarely on the unification of teleological and mechanistic models of explanation.

In the course of describing the development of this research tradition, I hope to dispell two further misconceptions that prevail in the literature treating early nineteenth century biology. In keeping with the dogma that in the life sciences one is either a vitalist or a mechanist, it is usually assumed that the proponents of teleology are vitalists. My study attempts to show that in the early nineteenth century the central issue was not vitalism as such, but rather the more interesting problem of causality in biology. To the German biologists who fashioned the research tradition discussed here teleological relationships offered themselves as more sensible patterns for investigating the causal relations of organic form and function.

A second assumption challenged by my study is that persons who defended

teleological thinking in the life sciences were fundamentally motivated by religious concerns. Several of the figures treated here, such as Immanuel Kant and Johannes Müller, certainly were deeply religious men. Some, such as Karl Ernst von Baer, were not religious in an orthodox sense but held a profound, almost pantheistic reverence for nature. But the issue that motivated them to adopt and tenaciously defend teleological thinking in the life sciences was not religion; it was, I hope to show, a concern for good science.

Once the problems of biocausality as perceived by early nineteenth century German biologists are sorted out, the outlines of a powerful program of empirical research begin to take shape. This book traces the main lines in the development of that program. Among the topics explored are its ramifications for work in functional anatomy, embryology, animal systematics, and physiology, particularly the cell theory, early work on heat production in animals, metabolism and muscle action.

It is my hope that this study will also contribute to scholarship on the history of evolutionary theory. One of the objectives of the biological tradition discussed here was to construct a theory to account for the apparent interrelations between organisms. The model eventually devised was a limited form of transformation confined to major organizational types. The principal architect of this view was Karl Ernst von Baer. Von Baer's 'non-Darwinian' theory of evolution should be of some interest to contemporary theorists, who in recent years have proposed a 'punctuated' model of evolution to account for evidence indicating that most species survive for a hundred thousand generations or even more without significant change and for the fact that evolutionary divergence appears to take place rapidly. Although his model was based squarely on the premises of a teleological framework of explanation which led him to propose a different means for explaining evolutionary change, von Baer called special attention to the inadequacies of a gradualist model, and his own 'non-Darwinian' model was based specifically on evidence from the fossil record which indicated that groups of organisms emerge rapidly and undergo little change for many generations before becoming extinct.

If there is a central figure in my study, it is von Baer, and one of the principal aims of this essay is to call attention to von Baer's role as a major biological theorist during the nineteenth century. In most historical treatments of nineteenth century biology von Baer is mentioned for his empirical discoveries, such as the mammalian ovum, and for his unparalleled skill as a microscopist. Not infrequently Johannes Müller is cast as the leading

theoretician of the teleological and morphological tradition in early nineteenth century German biology. But at nearly every major turning point in the historical development of the research tradition discussed here I have found the ideas of von Baer in the background. He was a constant source of bold ideas for placing the various branches of the life sciences on consistent, unified foundations.

Few studies have ever profited more from the assistance and advice of teachers, friends and colleagues than this one. Having been emboldened to undertake an investigation of German science in the Romantic era several years ago by Frederick B. Churchill, whose enthusiasm for German culture proved to be as infectious for his students as his concern for the history of the life sciences, I had the subsequent good fortune of making the acquaintance of three persons who have been constant sources of insight and encouragement for this project. They are Phillip R. Sloan, William Coleman, and Reinhard Löw.

For two years while we were colleagues together at Notre Dame, Phil and I teamtaught a course based on primary materials in which we contrasted the teleological and mechanistic approaches to the problems of physiology and evolution. For the purposes of that course I defended the methodological position of the Newtonian mechanist, while Phil adopted the view of Aristotle, Harvey, Owen, Haldane and Polanyi. Those were some of the most delightful and intellectually stimulating debates I have ever been party to; and for me at least they have continued, giving birth to the present book. The students in those classes will, I am sure, not be surprised to learn that Phil's view has prevailed!

My understanding of the issues regarding teleological and mechanistic approaches within German biology has also been shaped by an almost continuous dialogue with Bill Coleman. The Bell System has profited immensely from this book, but I have been a grateful beneficiary of Bill Coleman's expertise and guidance in this area.

Reinhard Löw has not only been a valuable critic of various versions of this book as it has progressed over the last two years, but he has also assisted in locating and calling my attention to several important manuscript sources. I am especially indebted to him for transcribing sections of Kiehmeyer's manuscript, "Allgemeine Zoologie", and for locating the Leuckart-von Baer correspondence discussed in Chapter 4. More important by far, however, has been his encouragement of the project and the many pleasant hours we have spent discussing Kant's philosophy of biology. My appreciation of the nature and importance of teleological explanations in biology is due in large part to

my association with Reinhard Löw and his important work in this area.

Several persons have offered valuable criticisms of portions of my work as it has progressed. Frederick Gregory read and thrashed the first draft. Many revisions have been due to his helpful criticisms. A series of major revisions in my interpretation of von Baer's embryology and its relation to what I call his theory of limited evolution have been due to the careful consideration of the thesis I am advancing by Dov Ospovat. I am not sure that Dov would agree with my present formulation of the problem; but as it attempts to incorporate his valuable insights, I hope that it would have pleased him. Thanks are also in order for Paul Farber and Gerd Buchdahl for criticisms they have offered of several aspects of my approach to both the historical and philosophical problems treated here.

Portions of this book have appeared in different forms in two articles: 'The Göttingen School and the Development of Transcendental Naturphilosophie in the Romantic Era', *Studies in History of Biology*, 5 (1981), 111-205, published by Johns Hopkins University Press; and 'Teleology without Regrets. The Transformation of Physiology in Germany, 1790-1847', *Studies in History and Philosophy of Science*, 12 (1981), 293-354, published by Pergamon Press. Grateful acknowledgement is made to Johns Hopkins University Press and to Pergamon Press for permission to reprint these previously published materials.

I am grateful to the Württembergische Landesbibliothek and the Justus von Liebig Universität-Giessen for allowing me to quote from manuscript sources in their collections. Without the assistance of a NATO Postdoctoral Fellowship and a research grant from The National Science Foundation this research could not have been undertaken.

Thanks alone surely could not repay Marilyn Bradian for her incredible secretarial skills and her perseverance in preparing the manuscript in its many different drafts. Hopefully her nightmares in German will soon pass.

Finally, I owe a debt of gratitude beyond calculation to my wife and family. They are the true teleologists behind this study, for they have selflessly supplied the means to its end, which has often seemed hopelessly far from realization. For their trust and support I am forever grateful.