The Poverty of the Linnaean Hierarchy

A Philosophical Study of Biological Taxonomy

MARC ERESHEFSKY
University of Calgary

CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
10 Stamford Road, Oakleigh, VIC 3166, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

First published 2001

Printed in the United States of America

Typeface Times Roman 10.25/13 pt. *System* QuarkXPress [BTS]

A catalog record for this book is available from the British Library.

Library of the Congress Cataloging in Publication data

Ereshefsky, Marc.
The poverty of the Linnaean hierarchy : a philosophical study of biological taxonomy /
Marc Ereshefsky.
p. cm. – (Cambridge studies in philosophy and biology)
Includes bibliographical references and index.
ISBN 0-521-78170-1 (hardcover)
1. Biology – Classification – Philosophy. I. Title. II. Series.
QH83 .E73 2000
578′.01′2 – dc21 00-028945

ISBN 0 521 78170 1 hardback

Contents

Introduction

THE LINNAEAN SYSTEM RECONSIDERED

Three hundred years ago biological taxonomy was a chaotic discipline marked by miscommunication and misunderstanding. Biologists disagreed on the categories of classification, how to assign taxa to those categories, and even how to name taxa. Fortunately for biology, Linnaeus saw it as his divinely inspired mission to bring order to taxonomy. The system he introduced offered clear and simple rules for constructing classifications. It also contained rules of nomenclature that greatly enhanced the ability of biologists to communicate. Linnaeus's system of classification was widely accepted by the end of the eighteenth century. That acceptance brought order to a previously disorganized discipline. Furthermore, it laid the foundation for "the unprecedented flowering of taxonomic research" of the late eighteenth and early nineteenth centuries (Mayr 1982, 173).

Linnaeus himself seemed assured of his place in the history of biology. Consider the frontispiece of his *Hortus Cliffortianus* (1737) (Figure I.1). Linnaeus's youthful face is seen on the body of Apollo. In one hand he holds a light, in the other he pushes back the clouds of ignorance from crowned Mother Nature. With his foot Linnaeus tramples the dragon of falsehood. In the foreground, plants are brought for identification and two cherubs admire Linnaeus's centigrade thermometer. An exuberant illustration, and an immodest one – it was commissioned and approved by Linnaeus. The metaphors of the illustration are not completely unfounded; Linnaeus's work did usher in a golden era of biological classification.

In the last two hundred years, the theoretical landscape of biology has changed drastically. The foundation of Linnaeus's system was his

Figure I.1 The frontispiece of Linnaeus's *Hortus Cliffortianus* (1737). Courtesy of Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, PA.

biological theory – in particular, his assumptions of creationism and essentialism. These assumptions have gone by the wayside and have been replaced by evolutionary theory. Still, the vast majority of biologists use the Linnaean hierarchy and its system of nomenclature. Unfortunately, the system's outdated theoretical assumptions undermine its ability to provide accurate classifications. Furthermore, its rules of nomenclature, once prized for their ability to bring order to biological classification, are no longer practical. These problems are far from minor, for the Linnaean system is the backbone of biological classification and much of biology. The Linnaean system prescribes how to name and represent taxa and, in doing so, provides the template for displaying life's diversity. Moreover, the terms and concepts of the Linnaean system play a central role in biological theorizing. They frame all theoretical questions concerning groups of organisms above the level of the local population.

To get a better idea of the problems facing the Linnaean system, let us take a closer look at its theoretical assumptions. Among them is Linnaeus's conception of biological taxa. Linnaeus thought that species and other taxa are the result of divine intervention. Once a taxon is created, each of its members must have the essential properties of that taxon. The evolution of a species was foreclosed by God's original creation. Needless to say, Darwinism gives us a different picture of the organic world. Taxa are the products of natural rather than divine processes. Species are evolving lineages, not static classes of organisms. This conceptual shift in biological theory is well discussed in the literature and comes under many banners. Some authors talk of the "death of essentialism"; others refer to the "species are individuals" thesis. In broader perspective, this conceptual shift falls under "the historical turn" in biology, or what Ernst Mayr calls "population thinking."

Essentialism concerning taxa has fallen out of favor among evolutionary biologists, so this tenet of Linnaeus's original system has been dropped. Nevertheless, many of Linnaeus's original principles remain in place, and those assumptions, I will argue, are equally problematic. Consider Linnaeus's conception of the species category. The species *category* is the group of all species taxa, whereas species *taxa*, such as *Homo sapiens* and *Drosphila melangaster*, are groups of organisms. For Linnaeus, not only do species taxa have essences, but so does the species category. In the Linnaean system, all species taxa are comparable and distinguishable from all other types of taxa. The assumption

that there is an essence to the species category is still widely held. Many biologists believe that species are groups of organisms that can successfully interbreed and produce fertile offspring. Being a group of organisms with those properties defines membership in the species category. So while biologists have rejected the Linnaean assumption that species taxa have essences, they have, for the most part, retained the assumption that there is an essence to the species category.

That latter assumption, however, should be questioned as well. The idea that species are groups of organisms that successfully interbreed and produce fertile offspring is just one of many prominent definitions of the species category. (Biologists often refer to such definitions as "species concepts.") Another definition asserts that a species is a group of organisms bound by their unique phylogeny, and still another defines a species as a group of organisms that share a unique ecological niche. What are we to make of this variety of species concepts in the literature? According to some authors, there is a single correct description of the species category. The existence of more than one species concept, they suggest, merely reflects a lack of consensus among biologists on the nature of species. Against this view, I will argue that there is no single correct definition of the species category. The species category lacks an essence and is in fact multifarious.

This second view is species pluralism and runs counter to the Linnaean assumption that there is an essence to the species category. If one accepts species pluralism, then not only must essentialism at the level of species be abandoned, but so must essentialism at the level of the species category. Similar arguments have been used against the other Linnaean categories. Many biologists note that the higher Linnaean categories – genus, family, order, and so forth – are heterogeneous collections of taxa. Families, for example, vary in their ages as well as their degrees of inclusiveness. Calling a taxon a "family" indicates only that within a particular classification that taxon is more inclusive than genera and less inclusive than classes. This meaning of "family" has no ontological significance. Similar observations apply to the rest of the Linnaean higher categories. If the higher Linnaean categories lack significant defining features, then another major tenet of the Linnaean system is obsolete.

Biologists and philosophers have carefully examined the fate of essentialism concerning species taxa. However, very little attention has been paid to essentialism at the level of the Linnaean categories. We should look more carefully at the assumption that the Linnaean cate-

gories have essences, not only because that assumption may be unfounded, but also because it underwrites many practices prescribed by the Linnaean system.

Consider the project of finding *the* definition of the species category, or the practice of finding *the* correct rank of a taxon. Suppose, as suggested, that the Linnaean categories, including the species category, are heterogeneous collections of taxa. If the taxa of a particular Linnaean category are not comparable on some significant parameter, then we should wonder about that category's existence. If the Linnaean categories do not exist, then the Linnaean ranks are ontologically empty designations. Nevertheless, we still assign taxa such ranks and, for the most part, think that those designations have significance. All species taxa, it is often assumed, occupy a unique and common role in the economy of nature. But we may have labored under a false assumption. Being wrong is bad enough, but when inappropriate theoretical commitments lead to practices that waste valuable research time, that mistake is compounded. If species taxa do indeed form a class of heterogeneous entities, then time and energy is wasted when we argue over *the* correct definition of the species category. Similarly, the assumption that the Linnaean categories represent real levels of genealogical inclusiveness in nature encourages biologists to argue over the rank of taxa; yet such disagreements may lack an objective basis for resolution. Accordingly, Willi Hennig complains that the continued use of the Linnaean categories is the source of many "unfruitful debates" in biological taxonomy (1969, xviii).

The ontological problems with the Linnaean hierarchy lead to further practical problems. The current Linnaean system contains a number of rules of nomenclature, many of which have their source in Linnaeus's original system. A centerpiece of those rules is the requirement that the Linnaean ranks of taxa be incorporated in taxon names. Species are given binomials, whereas more inclusive taxa are assigned uninomials. In addition, the names of many higher taxa have rank-specific endings. Unfortunately the ontological problems of the Linnaean categories undermine these rules of nomenclature. Suppose, as suggested, that the existence of the Linnaean categories should be doubted. We might then wonder if it is appropriate to indicate a taxon's rank in its name when such ranks correspond to nothing in nature. If there is no species category or genus category, then no taxon should be designated as a species or a genus. This is not merely a case in which certain scientific concepts are idealized representations that nonethe-

less approximate the natural world. The Linnaean categories may have no basis in nature.[1]

There are other problems with the Linnaean rules of nomenclature regardless of whether one is skeptical of the Linnaean categories. The simple requirement that a taxon's name indicate its rank causes needless instability in biological taxonomy. Classifications of the organic world are constantly revised in light of new evidence, and often such revisions require that the ranks of taxa be altered. The Linnaean system makes such revisions doubly hard. Biologists must change not only the taxonomic positions of taxa but also their names. The need to revise classifications is an epistemological problem that cannot be eliminated from biological taxonomy. Nevertheless, we would like classifications to remain as stable as possible. The instability of a taxon's name can be avoided if we drop the Linnaean requirement that a taxon's name contain information about its taxonomic position. The Linnaean rules of nomenclature lead to further practical problems. For instance, when biologists disagree on the rank of a taxon they are required by that system to give two different names (each indicating a different rank) to what they agree is the very same taxon. The list of problems continues.

Stepping back, the following can be said of the continued use of the Linnaean system. Taxonomists and philosophers of biology are familiar with the death of essentialism concerning species taxa, but that change in thought concerns only a small portion of the Linnaean system. Many problematic aspects of that system remain in place and continue to guide the vast majority of taxonomists in constructing classifications. Given the problems facing the Linnaean system and that system's importance in biology, a philosophical investigation of the Linnaean system is sorely needed. The aim of this book is to provide that analysis. We will begin with such broad issues as the nature of scientific classification and eventually work our way to specific recommendations for a post-Linnaean system. In an effort to give a clearer idea of what is to come, the remainder of this introduction provides a survey of the book's chapters.

An Overview of the Book

Starting at a rather global level, *The Poverty of the Linnaean Hierarchy* explores various philosophical problems in biological taxonomy. Many of these issues appear in both biology and philosophy, though

under different guises. Philosophers would like to know how best to represent the world's entities, what the relationship is between theory and classification, and other such questions. Biologists are interested in the same questions, but in the more restricted domain of biology. This book examines how the quest for scientific classifications has occurred in biology by looking at the Linnaean system of classification. But before getting to the details of biological taxonomy itself, we need an introduction to some of the issues in the philosophy of classification. Chapter 1 outlines various philosophical approaches to classification, from essentialism to Wittgenstein's notion of family resemblance to more recent suggestions of homeostatic cluster kinds. Because much of this book is devoted to the historical turn in biological taxonomy, a large part of Chapter 1 discusses the notion of historical classification and the identity and individuation of historical entities. It is one thing to say that a particular taxon is a historical entity; it is another to give precise conditions for its identity. Other debates in the philosophy of classification are surveyed, such as the debate between monists and pluralists and the debate between realists and anti-realists. Chapter 1 provides a menu of options one can choose from in developing a philosophy of classification.

Chapter 2 turns to biology proper and is a primer of biological taxonomy. All active scientific disciplines contain theoretical disagreements. The same is true of biological taxonomy, though the disagreements there are more properly described as disagreements over the appropriate methods for developing classifications. Contemporary biology contains no fewer than four general schools of taxonomy: evolutionary taxonomy, pheneticism, process cladism, and pattern cladism.[2] When one turns to the literature on the nature of species, the number of options increases. The first half of Chapter 2 introduces the major schools of biological taxonomy, while the second half introduces six prominent species concepts. The debate among biologists over the proper school of taxonomy has been heated and at times rancorous. I will try to stay out of the fray in this chapter (though I will take sides in later chapters). Chapter 2 merely provides the biological background for the philosophical problems discussed in later chapters. For those well acquainted with contemporary biological taxonomy, the material in Chapter 2 will be familiar. For those lacking a strong background in the field, Chapter 2 provides important information for understanding the topics discussed in later chapters.

An issue that has come to the fore in recent years is the ontological

status of biological taxa, especially species. Many have argued that a Darwinian view of biological taxa requires that we treat taxa as historical entities rather than as classes of similar organisms. Traditionally, philosophers as well as biologists have treated taxa as qualitative kinds, where membership turns on the organisms of a taxon being similar to one another in one or more respects. Chapter 3 demonstrates why qualitative approaches to classification, from essentialism to Richard Boyd's homeostatic cluster kinds, fail to provide adequate accounts of biological taxa. Instead, a historical approach, one that views taxa as wholes whose parts (organisms) are causally connected, should be adopted. One component of the historical approach is the "species are individuals" thesis. Much ink has been spilled in the debate over whether species are individuals, yet key elements of that debate remain unresolved. For one, the term "individual" is ambiguous and that ambiguity is a source of disagreement and confusion. Chapter 3 offers an analysis of individuality that disambiguates that notion. It also makes clear what is and is not significant about the claim that species are individuals. Some authors have argued that the "species are individuals" thesis has broad and profound implications for evolutionary theory. The message I will convey is that the historical turn in biological classification does have important ramifications for constructing biological classifications. However, the alleged broader implications of the individuality thesis – for example, that it affects the nature of evolutionary theory as a scientific theory – are not forthcoming.

Having dealt with the question of essentialism at the level of taxa, we turn to the question of essentialism at the level of the species category. Should we assume that there is a single correct definition of the species category, as essentialism dictates, or should we allow that there might be a number of different types of species taxa? Species monism is the traditional view, stemming from essentialism. Species pluralism parts with that view and maintains that there is no essence to the species category. The job of Chapter 4 is to provide a comprehensive argument for the acceptance of species pluralism. Reduced to its barest bones, the argument of Chapter 4 suggests that species pluralism reflects the fecundity of nature, not our lack of understanding of the organic world. Biological forces, it is argued, cause the existence of different types of base taxa. The claim here is ontological, and it is quite different from the epistemological argument that we should prefer pluralism because we lack sufficient evidence to choose one species concept over another. The advocacy of species pluralism is not new to

this book, but the arguments presented here differ from those previously found in the literature.

Monists are not happy with the advocation of species pluralism. One objection raised by monists stands out and deserves special attention. Pluralists, they argue, fail to provide adequate criteria for determining which species concepts are worthy of acceptance. Without such criteria, species pluralism allows the acceptance of any suggested classification. Some monists conclude that species pluralism boils down to a position of "anything goes," a position that poses an important methodological challenge to pluralists. Chapter 5 attempts to meet that challenge. We could reflect philosophically on which criteria should be used for selecting species concepts; but we might end up with criteria that are irrelevant to the aims of working taxonomists. A better way is to establish the aims of biological taxonomy, according to biological taxonomists, and then determine which criteria pick species concepts that best satisfy those aims. Larry Laudan calls this approach to scientific methodology "normative naturalism." We derive rules for picking theories, or species concepts, according to the aims of the discipline at hand. The word "naturalism" is used to contrast this sort of philosophy of science from one that determines criteria for selecting theories on just the basis of conceptual, or armchair, analysis. With such criteria in hand, pluralists can say which taxonomic approaches should be accepted and which should be rejected; they can show that pluralism is not vulnerable to the "anything goes" objection, but a position with careful checks in place.

The discussion of species pluralism leads us back to more general questions about the continued use of the Linnaean hierarchy in biology. If the organic world consists of different types of species taxa, and there is no parameter common to species taxa that distinguishes them from other types of taxa, then the species category has lost much of its significance. Similar concerns affect the status of the other Linnaean categories. If the Linnaean categories lack an ontological foundation, then an important tenet of the Linnaean system, a tenet carried to this day, has been lost.

For this reason, and those mentioned earlier, a full scale examination of the Linnaean system should be conducted. The rest of this book is devoted to that task. The first order of business is an introduction to Linnaeus's original system and his motivations for that system. We then turn to the evolution of the Linnaean system, starting with the Darwinian revolution, working through the evolutionary synthesis, and

concluding with recent cladistic amendments. Though much has been written on Linnaeus's original system, little has been written on the subsequent evolution of that system. Chapter 6 sketches the transformation of the Linnaean system since its inception.

In the last fifty years, two versions of the Linnaean system have come to the fore. One is the traditional system offered during the evolutionary synthesis by Ernst Mayr and Gaylord Simpson. The other is Edward Wiley's annotated Linnaean system. Wiley's system is a cladistic version of the Linnaean system designed to overcome the problems of the traditional system. Wiley's system does avoid some of the problems facing the traditional system. However, many problems of the traditional system are carried over to Wiley's system. Moreover, Wiley's annotated Linnaean system brings its own problems. Chapter 6 introduces the problems facing traditional and cladistic versions of the Linnaean system. Chapter 6 also suggests why the Linnaean system remains entrenched in biological taxonomy despite its lack of a theoretical foundation.

The problems facing the Linnaean system are significant enough for us to consider the possibility of adopting a non-Linnaean system of classification. But before doing that, we need an alternative system. Saying that the Linnaean system is flawed is one thing; providing a compelling argument for its replacement is quite another. An important step in establishing that the Linnaean system should be replaced is developing an alternative system. A number of post-Linnaean systems have been suggested in the last thirty years. Some proposals address new ways of displaying hierarchical relations, others discuss alternative methods for devising taxon names, still others provide non-Linnaean means for defining taxon names. Unfortunately, alternatives to the Linnaean system tend to be piecemeal, and they contradict one another. Chapter 7 attempts to bring order to this literature. First it examines various proposals for post-Linnaean taxonomy, then it selects the best of those proposals and weaves them together into a coherent alternative system. Again, the motivation here is to provide a viable alternative system to the Linnaean system, because without such an alternative, recommendations for dropping the Linnaean system will go nowhere.

With a post-Linnaean system in hand, we can compare the Linnaean system to a comprehensive alternative. If such a comparison is to be fair, we must contrast the post-Linnaean system with the best developed version of the Linnaean system. That version is Wiley's (1979,

1981) annotated Linnaean hierarchy. The first half of Chapter 8 compares the annotated Linnaean system with the post-Linnaean system developed in the previous chapter. The result is a scoreboard highlighting the desirability of each system. The second half of Chapter 8 steps back from a detailed examination of the annotated and post-Linnaean systems and considers a more general issue. Suppose the post-Linnaean system better coheres with evolutionary theory and, if adopted, would make the job of taxonomists easier. Suppose, in other words that the post-Linnaean system is preferable for both theoretical and pragmatic reasons. At first glance such reasons seem sufficient for adopting a new system of nomenclature, but in practice they are not. Given the pervasiveness of the Linnaean system both in and outside of biology, we need to show that the switch to an alternative system is practically feasible. More precisely, we need to show that the entrenchment of the Linnaean system does not foreclose the possibility of adopting an alternative system.

The Linnaean system has served biology well. Few would deny that. But biological theory has changed drastically in the last two hundred years. Those changes have rendered the Linnaean system both theoretically outdated and pragmatically flawed. One aim of this book is to show that biology is no longer well served by the Linnaean system. Another aim is to show that the replacement of the Linnaean system should be seriously considered.