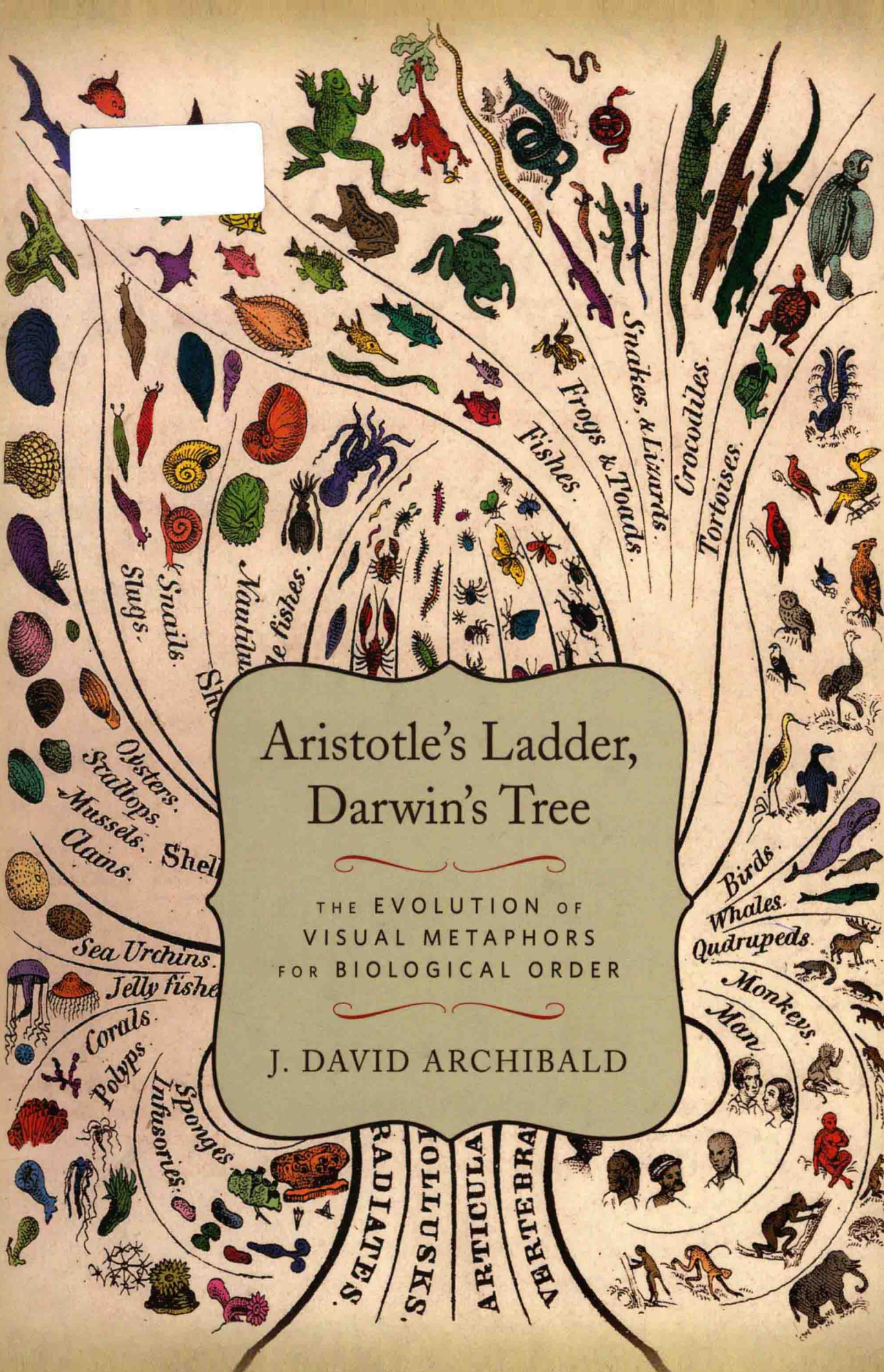

Aristotle's Ladder, Darwin's Tree

THE EVOLUTION OF VISUAL METAPHORS FOR BIOLOGICAL ORDER

J. DAVID ARCHIBALD

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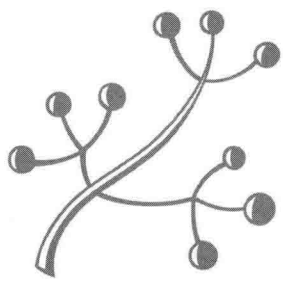

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J. David Archibald

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ARISTOTLE'S LADDER, DARWIN'S TREE

For my father,

James R. Archibald (1927–2013)

Preface

Every culture that has put chisel to stone or pen to paper has attempted to visualize the order in nature and our place in it. Some of the more intriguing representations of the natural biological order remain with us in the form of grandiose spirals hypothesizing the relationships of thousands upon thousands of species. We have come a long way, but we've become so comfortable with these representations that we must remind ourselves that they are poetic metaphors rather than the scientific history of life on planet Earth. We blithely presume an underlying reality—that this natural biological order came about by the process of evolution. This realization emerged succinctly in only the past two centuries, whereas our graphic images and schemata remain only metaphors for this process and for the pattern or patterns that emerged over the past few thousand millennia. Shockingly, even in the self-described advanced cultures the very fact of evolution remains controversial mostly because of religious zealotry and ignorance.

The acceptance of evolution as the greatest force underlying nature emerged in Europe as science ascended the remaining steps to the throne of rationality. As might be expected, the ideas of evolution and in particular its visualization did not suddenly appear treading on the heels of the Enlightenment; rather, they exhibit a long and sometimes tangled history within the Western tradition. Ladders and trees became the common but not the only icons. The growth and blossoming of visual representations over the past 2,500 years and what they meant to those who created them encompass the theme of this book.

How we visualized nature's order leading up to modern evolutionary biology by necessity includes or excludes various individuals and their ideas in a somewhat idiosyncratic manner. This pertains especially to important biologists from the nineteenth century onward. Accordingly, it must be emphasized that the basis

for including or excluding an individual relates most specifically to whether this individual contributed a visual representation of biological order or in a few cases a written description of how to represent biological order.

Placing past events within the context of time and place proved a daunting task. Supposedly the more we know, the easier the task becomes. But we then face the situation of more experts weighing in on the meaning of this visual metaphor or that narrative. It is, to be sure, a dubious, untidy process for us humans to try to objectify ourselves, because we deem ourselves exceptions to the rest of the natural world. Having spent most of my career studying long-dead species that never possessed such an exalted view (if they possessed any view) of themselves, I fortunately could eliminate the issue of hubris in the subjects of study.

Studying long-dead creatures and their environments presents many variables, but one is not their view of their place in nature. Especially given the newer techniques of placing long-extinct species within their environmental context, with the overlay of knowing that all such species remain subject to the ravages and rewards of evolution, we paleontologists pride ourselves in placing organisms in a proper context of time and place. Such is not the case when interpreting human history, even when written. We run the risk of trying to place these sometimes very ancient ideas within in a modern context and placing modern sensibilities on them.

In this book, then, the task is to see a diagram not as we now interpret it but as the author and intellectually curious consumers at the time perceived it. Such diagrams—ladders, stairs, trees, tables, bifurcating figures—meant one thing at the time they were created but, depending on the longevity of the figure, have affected both how we draw such diagrams today and how we interpret them. Does a tree figure with various species at its termini mean an evolutionary history? Does a simple bifurcating diagram of various species represent a genealogy? When we see diagrams of fish to amphibian to reptile to mammal to human, what do we perceive these representations mean? The answer depends on when and where the diagram appeared.

How do we measure progress in our understanding of the biological order? We can identify benchmarks—among others, Lamarck's use-disuse ideas and his "tree" in 1809; Darwin's natural selection and his hypothetical tree in 1859; Haeckel's many phylogenies in the latter nineteenth century; Simpson's help in reconciling Mendel and Darwin in the mid-twentieth century; and the rapid-fire introduction toward the end of the twentieth century of Hennig's cladistics, PCR, and related molecular techniques for phylogenetic reconstruction, and the repeatedly doubling of computing power. Building a scale of progress based on this sort of trajectory, we made slow progress for more than two thousand years, began picking up speed just over two hundred years ago, and turned vertically about fifty years ago. As we shall see, the visual metaphors for this incredible progress have not kept pace, and understandably so. As the number of species that we believe to exist and those we think exist took an equally astounding upward turn, our ability to put this in visual metaphors flagged. Who can grasp millions of interrelated species festooning the tree of life? Our computers can calculate and even attempt to draw such trees, but we must at some point simply look on in awe.

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A wealth of information came from other people. Giulia Caneva freely shared with me her ideas and interpretations of the vegetal friezes on the Ara Pacis. David McLoughlin inspired me to relate the apse mosaic in San Clemente to the Ara Pacis vegetal frieze. Sara Magister similarly directed me to the vegetal-motif mosaic occupying the apse in the narthex, or antechamber, to the Baptistery of the Papal Archbasilica of St. John Lateran. Luca Dejaco kindly provided a copy of the *Bell'Italia* article on the floor mosaic of the Cathedral of Otranto. John van Wyhe introduced me to the work of Anna Maria Redfield. Thanks to Malcolm Kotter for alerting me to the evolutionary trees in George William Hunter's *A Civic Biology*.

A number of online sources proved immensely helpful: the American Museum of Natural History Darwin Manuscripts Project, the Biodiversity Heritage Library, the Darwin Correspondence Project, Darwin Online, and Google Books. I greatly appreciate the American Philosophical Society Library, the Cambridge University Library, the Huntington Library, and their staffs for allowing me to use materials

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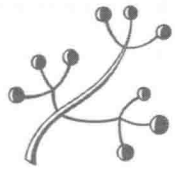
ARISTOTLE'S LADDER, DARWIN'S TREE

Contents

CHAPTER ONE



Blaming Aristotle

Our perceptions as well as our misperceptions of the history of life on this planet arise in large measure from the representations of evolutionary history, both verbal and visual. One need not be a biologist to understand the meaning of "lower" and "higher" animals. Images abound showing the march of primate evolution from a lowly, monkey-like ancestor to the pinnacle of humanness—*Homo sapiens*. We do, of course, deem ourselves as the highest animals—in the Western tradition, just below the angels. But what do we mean with these seemingly innocuous adjectives? What makes us presume that we are the highest of animals: are we closer to God, are we more complex, are we more highly evolved?

Natura Non Facit Saltus

We can blame Aristotle (384–322 B.C.E.). Aristotle's views come to us in his ten books titled *Researches About Animals*, more commonly known from the Latin translation *Historia Animalium* (*The History of Animals*). His classification of life accorded with the then accepted views of the four basic elements of nature (air, fire, water, earth). Aristotle defined groups often in apposition, such as "bloodless" animals and "blooded" animals, which basically correlate today with what we call invertebrates and vertebrates. These two groups were then further subdivided into what he called observable "forms" (*eidê*), larger groups, or "kinds" (*genê*). The Latin words *species* and *genera* only loosely correspond to what we today mean by species and genera. Although the relative hierarchy of species as subsets of genera still pertains, Aristotle used these terms for much larger sets of animals (Mayr 1985; Gagarin 2009).

Of particular interest here, Aristotle also provided the first surviving attempts in the Western world to arrange inanimate and animate objects in some ordered sense based on their level of complexity. Even if images of his system ever existed, none survives, yet his brief description suffices to make it quite clear what he intended:

> Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie. Thus, next after lifeless things in the upward scale comes the plant, and of plants one will differ from another as to its amount of apparent vitality; and, in a word, the whole genus of plants, whilst it is devoid of life as compared with an animal, is endowed with life as compared with other corporeal entities. Indeed, as we just remarked, there is observed in plants a continuous scale of ascent towards the animal. (Aristotle 2007:8.1)

Certainly species across groups share characters; thus Aristotle sees the scale or ladder as forming a continuum, a succession without gaps from inanimate objects through plants and then to animals, thus *natura non facit saltus* (nature makes no leaps). Boundaries between groups do occur; we simply cannot discern them because of the continuous nature of characters shared by the various groups (Balme, in Aristotle 1991). Aristotle provides us with an explicit statement concerning the *scala naturae*, but he does not propose an evolutionary basis for this continuity. Aristotle did not support claims of earlier ideas of evolution made by other Greeks; such claims using Aristotelian *scala naturae* come much later. Rather, for Aristotle all was cyclic, with no beginning and no end.

Aristotle greatly influenced later writers on the same topic. Some four hundred years later, the Roman Pliny the Elder (Gaius Plinius Secundus, 23–79 C.E.) organized his thirty-seven-volume *Naturalis Historia* (*Natural History*) along the lines of Aristotlean *scala naturae*. Although the name would imply a work concerned with what now we call natural history, Pliny produced a far broader work that included various aspects of Roman culture. We do not know if Aristiotle would have approved, but unfortunately, as with Aristotle, if Pliny produced any stairs of nature they do not survive.

Pliny shared his Stoic philosophy (that misfortune and virtue are sufficient for happiness) with the Roman consul and orator Marcus Tullius Cicero (106–43 B.C.E.), specifically that purpose and design exist in nature, including humans' place within it. These views carried forward as Christianity came to political and social power in Europe. It must be said that these views, while monolithic, were not universal. Not all Romans of similar antiquity shared Pliny's Stoic approach. The first-century B.C.E. Epicurean Roman philosopher Lucretius (Titus Lucretius Carus, ca. 99–ca. 55 B.C.E.) accepted that there are gods but that they have no interest in humans, that the universe has no creator and was not created for humans, and that nature ceaselessly experiments (Greenblatt 2011). Troublemakers always nip at the heels of authority. Nevertheless, the Stoic philosophies and Aristotelian *scala*