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## *Phylogenetics: A Catalyst for a Biophilic Revolution?*

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### **Abstract**

*A biology framework in Environmental Education can inspire biophilia, the love for the complex array of lifeforms on this planet, in students. In this paper, a simple, multi-scaled phylogenetic tree is presented to express such a framework. When viewing life from a framework such as a phylogenetic tree, the human species is seen as just one part of something vastly complex. This view is contrasted to another framework, more anthropocentric in nature, that seems to be more typical in the developed world. Challenging students to view the role of humanity from a biocentric, rather than anthropocentric, framework can lead to a greater appreciation of the diversity of life. This, in turn, could be a catalyst for a biophilic revolution, reducing environmental problems and lead to a more ecologically-minded status quo.*

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### **Keywords: Environmental Education, Biology, Biophilia, Phylogenetics**

Many of the current social and environmental issues facing this world stem from humanity's trend toward emotional disconnection from the rest of the natural world (Roszak, Gomes, & Kanner, 1995). This disconnection goes against the innate human desire to affiliate with the non-human world, a condition known as "biophilia" (Wilson, 1984). A potential healing strategy for the world is to bring on a "biophilic revolution" in which humans start to live in a way that meets their needs in a manner that shows respect for non-human life (Orr, 1994). I believe that environmental educators are in a position to inspire such a revolution.

The way in which environmental discussions are framed has a significant impact of the way an audience will emotionally respond (Myers, Nisbet, Maibach, & Leiserowitz, 2012). In my experience, using phylogenetics as a framework for environmental discussion, paired with my own sense of biophilia, can gently guide my audience to an emotional outcome of love for the immensity of this world's biodiversity and hope for the future. These outcomes go hand-in-hand with biophilia (Wilson, 1984) and increase the likelihood that positive changes will arise from environmental discussions (Ojala, 2012).

In this paper, I present a simplified phylogenetic tree to be used as a tool for environmental educators (Figures 1 through 4). I conclude with a broader context for phylogenetic trees, including ways for educators to use them as a model for discussing environmental and social justice issues (Figure 5). I have created these figures using the Interactive Tree of Life (iTOL), a free-access program based on genetic sequencing data (Letunic & Bork, 2016). A phylogenetic tree, commonly known as the tree of life, is a

powerful model for the diversity of life on this earth. These branching figures express the immensity of biodiversity and how different types of organisms are related to one another (Campbell & Reece, 2002). For more information on the history and evolutionary meaning of a phylogenetic tree, see Woese (2000)

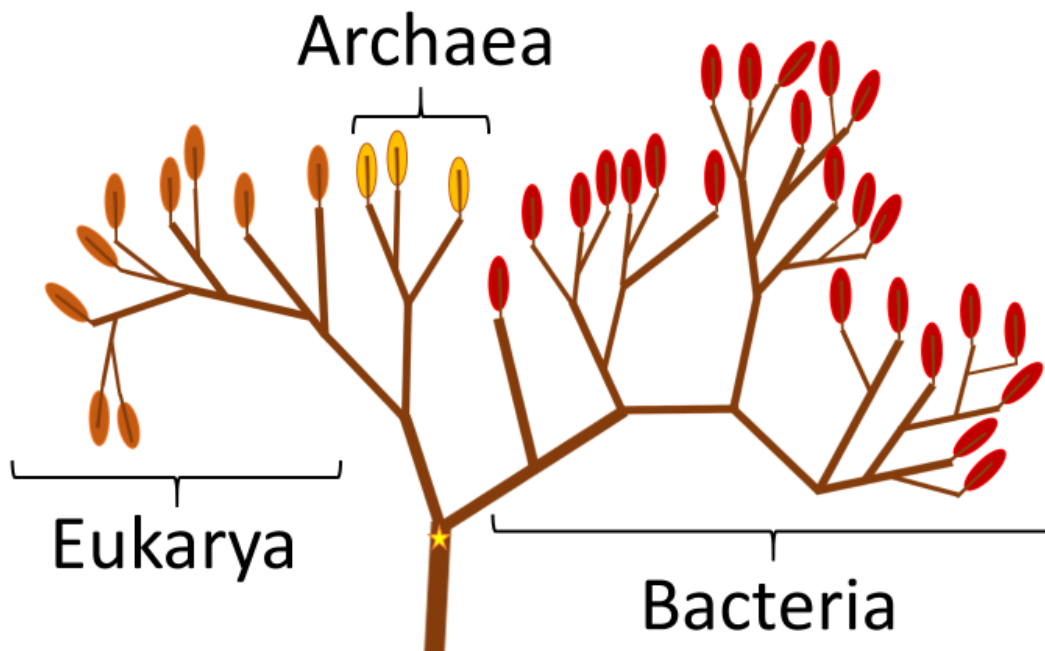


Figure 1: A phylogenetic tree representing all of known life

The phylogenetic tree in Figure 1 shows that all of known life on this planet is broken into three domains: Eukarya, Archaea, and Bacteria. As is the convention with phylogenetic trees, (Campbell & Reece, 2002) branches furthest from the base of the tree (marked with leaves on this figure) represent groups of organisms that are currently living. As a simplification, I have not included any branches for extinct groups of organisms in any of my figures.

Another convention of phylogenetic trees is that nodes where branches connect represent common ancestors which have evolved to create the outward branches (Campbell & Reece, 2002). The node that is closest to the center of Figure 1 (marked with a star) represents the Last Universal Common Ancestor (LUCA), the lifeform from which all life was ultimately derived (Le Page, 2014). I believe that LUCA is at the core of biophilia: we are drawn to other life, because it is our kin.

The most numerous and diverse lifeforms on this earth are bacteria (Campbell & Reece, 2002). Life as we know it would not be possible without this myriad of microscopic beings. For example, humans are dependent on bacteria that live within our bodies and help us with basic functions like digestion (McKie, 2014) and vitamin production (Pollan, 2013). In fact, there are significantly more bacteria cells within the human body than

there are human cells that make up the body (Sender, Fuchs, & Milo, 2016). Archaea are similar to bacteria, but share certain cellular properties with members of Eukarya, known as eukaryotes (Campbell & Reece, 2002).

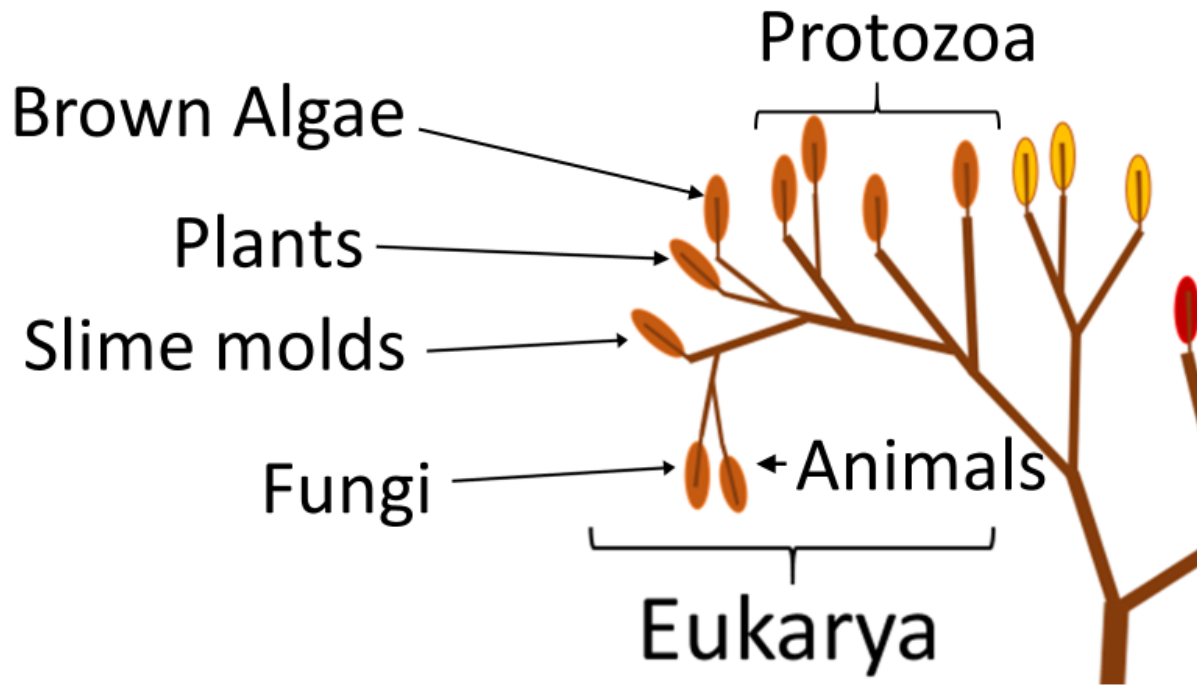


Figure 2: A phylogenetic tree representing Eukaryotic life

If each domain were to be looked at individually, they would form their own phylogenetic trees. Figure 2 is the tree of the domain Eukarya. All of the lifeforms that can be seen with the unaided human eye, as well as single-celled protozoa, are eukaryotes. They are distinguished from other life-forms by the presence of membrane-bound cellular compartments, known as organelles (Campbell & Reece, 2002). It is not known how many species of eukaryotes there are. Estimates have ranged from less than 9 million (Mora, Tittensor, Adl, Simpson, & Worm, 2011) to over 200 million (Brusca & Brusca, 2003). The discrepancy is largely due to the fact humans have only formally classified a small portion of the life of this planet. According to Brusca & Brusca (2003, p. 4): “At our current rate of species descriptions, it would take us 2,000-8,000 years to describe the rest of Earth’s [eukaryotic] life”

Each orange leaf in Figure 2 represents a eukaryotic kingdom which includes a wide range of complex, diverse, and (dare I say) beautiful beings. One of those kingdoms is the Animalia, the animal kingdom, of which over a million species has been formally described (Brusca & Brusca, 2003). If we were to look closer at this leaf (see Figure 3), or any other leaf found in Figure 1, we would see another phylogenetic tree imbedded within it.

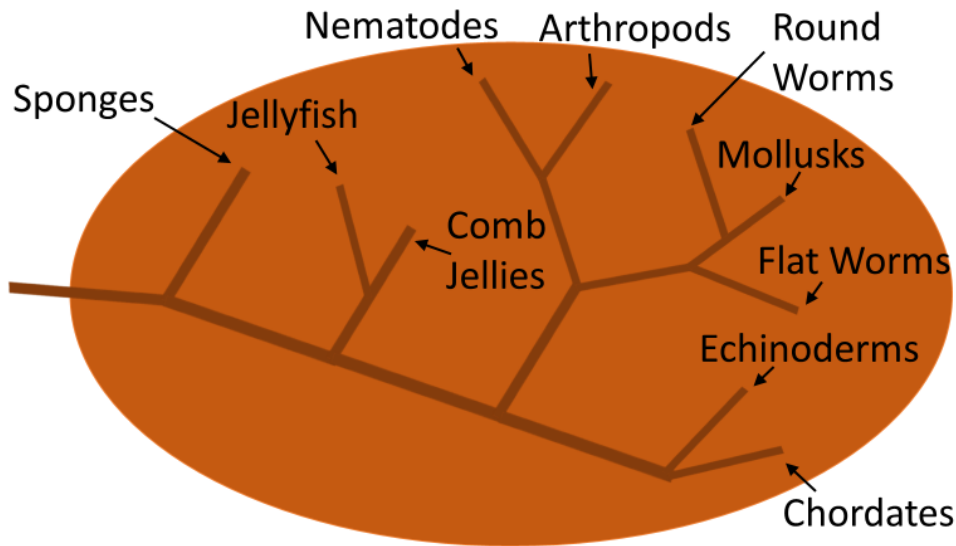


Figure 3: A phylogenetic tree representing animal life

Animals are broken up into 34 distinct phyla (Brusca & Brusca, 2003), but this figure has been simplified to only represent the phyla that are most common. Over 95% of animal species are invertebrates (Brusca & Brusca, 2003). All animals that have an internal bony skeleton belong to the phylum Chordata (the chordates). Figure 4 shows the phylogenetic tree that can be found if we take a closer look at the chordates.

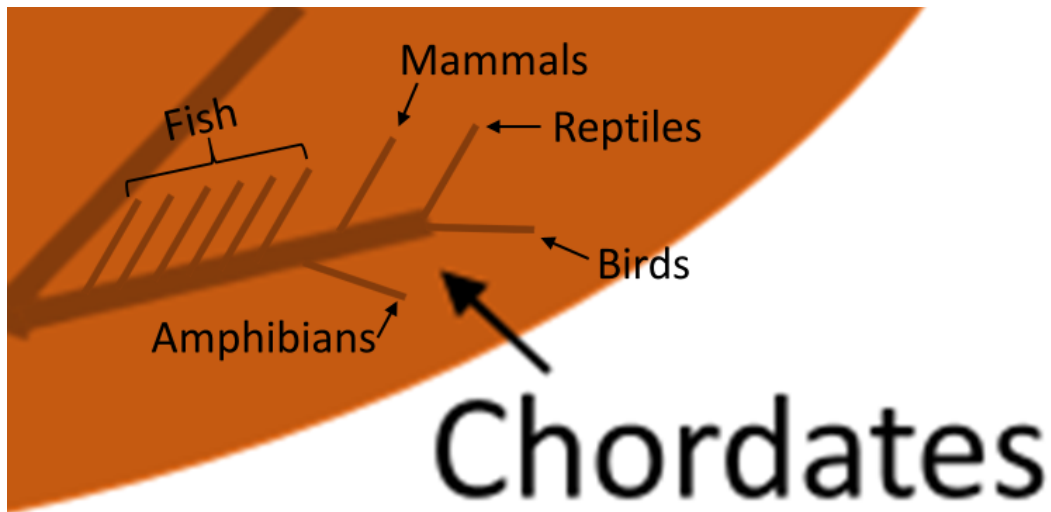


Figure 4: A phylogenetic tree representing chordate life

This image shows the major classes of phylum Chordata, all of which belong to the subphylum Vertebrates. Over 46,000 species have been described in this subphylum (Brusca & Brusca, 2003). One of the classes of Chordata is class Mammalia, the mammals.

This group is generally furry and includes about 4,500 species with females that produce milk for their babies (Campbell & Reece, 2002). If I were to continue with my tree of life metaphor, the human species would appear as a single organelle within a cell that makes up a tissue that exists within a stem of a vein of a leaf on the tree of life.

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**Conclusion**

For me, this is what biophilia is all about: to be a small part of a living system that is so big and so complex that I could never truly conceive it from my organelle-like vantage point. I try to share this viewpoint as frequently as possible. I have successfully included biophilic discussions using phylogenetic trees for elementary school children and adults. I have included it in lectures on topics ranging from estuaries to business sustainability. I believe that spreading this idea could start a biophilic revolution.

When viewing world from a biophilic framework, it seems a crime for comforts of human beings to come at the cost of whole ecosystems. In contemporary western society, however, we tend to think of humanity as separate from the rest of the living world (Schultz, 2002). It seems to me that the value of most people, and all other life, tends to be judge relative to a subset of privileged humans that are deemed as having inherent worth. I represent this relationship in Figure 5.

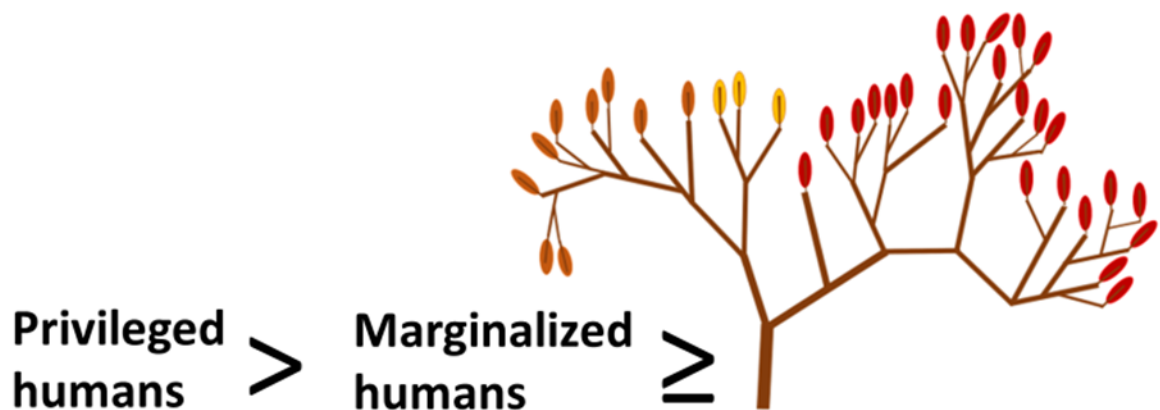


Figure 5: a model for contemporary western hierarchy of life

There are many examples of this relationship in our society. One is the growing trend for “fast fashion”, in which resources are increasingly being used for clothing that is designed to become waste in a short order of time. This model grants inherent value to people desiring a constant instream of wearable status symbols and the people who stand to gain financial wealth from providing such services. Of less concern are the impoverish third-world nations suffer in terms of culture and local economy as they end up with

much of this clothing waste (Claudio, 2007). Of even less concern are the myriads of lifeforms that suffer from all the environmental degradation caused by the making and transporting of these mass quantities of clothing (Allwood, Laursen, Rodríguez, & Bocken, 2006).

It is my belief that if the popular viewpoint of human's role in the world were to switch from that of Figure 5 to that of Figure 1, many of our big environmental and social problems would naturally become better. As E.O. Wilson said in the conclusion of the prologue to his book titled *Biophilia* (Wilson, 1984, p. 2): "[As] we come to understand other organisms, we will place a greater value on them, and on ourselves". Phylogenetics is a tool to bring such a sense of value to our communities, which, in my view, is largely the point of environmental education.

A handwritten signature consisting of the letters 'S2SS' in a cursive, stylized font. The signature is enclosed within a light blue diamond-shaped background.

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