Phylogenetic assessment of the evolution of the fictional races of Tolkien across multiple fictional universes

Jermaine Mahguib

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INTRODUCTION

The high fantasy races of J. R. R. Tolkien, as he described them, became the basis for races that inhabit numerous universes in modern fiction. Here the term ‘race’ is used freely to refer to fictional, reproductively independent species of intelligent human-like peoples inhabiting fantastical worlds; the term is used ubiquitously in fantasy and science-fantasy based literature, and commonly employed in open discussions on these intellectual properties (IPs).

Permutations of Tolkien’s elves, dwarves, humans and orcs are found across a broad range of written literature and published video game series, each adding new physical features, behavioral ranges and story roles, while retaining others from the original descriptions. For example, in Tolkien’s fictional works, the elves fill the archetypal role of the ‘old man,’ the ancient first race to inhabit the world. In the contemporary timelines of Tolkien, the elves are a race whose time of prominence has come and gone, and they serve as a fount of wisdom on matters of history and ancient arcana, and are often thrust into the role of providing some form of guidance for younger races. This archetypal role is often maintained in derivatives of the race across fictional universes.

Other examples of retained traits include the dwarves’ affinity for occupying subterranean domains, the humans’ tendency to expand their empires, and the orcs’ green skin and ‘monstrous’ visages. Conversely, a number of traits have seen some drift from Tolkien, such as the role that the orc race plays in stories. While Tolkien’s orcs were portrayed as vile and heinous, and this persisted across other IPs, some universes established their orc peoples as being more on par with their other ‘noble’ races (e.g. humans, elves and dwarves).

In the present study, a suite of traits that describe the core races of several fictional universes was established and a character state matrix was created to provide a dataset for phylogenetic analysis in order to assess how these races have evolved from Tolkien’s original incarnations. Character traits were categorized into three classifications: physiological traits, behavioral traits, and archetypal traits. For example, comparative physical *strength* of typical members of a given group was categorized as a physiological trait, while *aggression* level was categorized under behavioral traits.

Character state matrix data was used in a set of maximum likelihood (ML) analyses in an attempt to address two primary questions: (1) do various incarnations of Tolkien’s fictional races from different IPs form statistically supported phylogenetic clades; (2) in what categorical respects (physiological, behavioral or archetypal) have the original high-fantasy races of Tolkien diverged the most across multiple incarnations?

The former was approached via a ML analysis using character state sequence data from all three trait categories concatenated. If the tested IPs exhibit minimal alteration to character traits describing their fictional races relative to the type races of Tolkien, then we can expect to see, for example, all elven derivatives forming a supported clade in the tree topology. If, however, the fictional peoples of fantasy IPs have substantially deviated in our established character traits across universes, then we can expect the topology of the tree to suggest few if any supported clades, and instead observe a tree characterized by polytomies.

To address the second question, phylogenetic trees were generated using categorical sequence alignments separately, and compared to one another; in other words, trees were estimated using aligned character state sequences from the physiological traits category, others from the behavioral traits and archetypal traits categories. If a category of character traits has experienced less deviation from the original Tolkien descriptions, then we would expect to see distinct clades in the tree topology, were all elves form a group, all dwarves, etc. If, on the other hand, some incarnations of Tolkien’s fictional races have experienced substantial categorical deviation, then we might expect to see more polytomies or a single large polytomy in the tree topologies.

METHODS

*Taxa and Multistate Sequence Data*

A total of 70 traits (32 physiological, 20 behavioral and 18 archetypal) were considered for this study, each assigned a set of numerically coded states (see Tables 1 – 3). The number of different states per trait varied from 2 to as many as 7, though the majority of traits were coded as having between 3 to 5 states. The 70 character traits were scored for a total of 32 taxa hailing from one of seven fictional universes: 4 taxa from J. R. R. Tolkien’s *The Lord of the Rings*; 5 from Ed Greenwood’s Dungeons & Dragons-inspired *The Forgotten Realms* series of novels and games, produced by various authors and publishers; 5 from Bethesda Studios’ *The Elder Scrolls* series; 5 from Blizzard Entertainment’s *Warcraft* series; 5 taxa each from Games Workshop’s *Warhammer* and *Warhammer 40K* series of novels and games, produced by varies authors and publishers; and 3 taxa from CD Projekt Red’s *The Witcher* series, adapted from the novels by Andrzej Sapkowski.

Four additional taxa were selected and scored for use as outgroups in phylogenetic inference: 2 taxa from Blizzard Entertainment’s *Starcraft* series; an additional taxon from Games Workshop’s *Warhammer 40K* series; and 1 taxon from film series, novels and graphic novels based on Dan O’Bannon and Ronald Shusett’s *Alien*. All taxa, the respective fictional universes to which they belong, and the numerical sequence of trait scores extracted from the character state matrix are shown in Table 4. All character states in a given category, for a given race, were determined relative to other members of the same universe; cross-universe comparisons were not considered when determining character states for taxa.

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| state matrix. The scores of the matrix were used as sequence alignments for phylogenetic inference. |  |  |  | 7 = variable |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 6 = varies among members of group |  | 6 = black |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 5 = 1 ft or more taller than average human | 5 = varies among members of group | 5 = golden skin tones |  |  |  |  |  |  |  |  |  |  |  |  |  | 5 = no ears |  |  |  |  |  |  |  |  |  |  |  |  | 5 = varies among members of group | 5 = low to high magical aptitude | 5 = low to high psychic aptitude |
|  | 4 = slightly taller than average human | 4 = bulky and muscular | 4 = purple or blue or grey skin tones |  |  |  |  |  |  | 4 = varies among members of group |  |  |  |  |  |  | 4 = very elongated |  |  |  |  |  | 4 = monstrous | 4 = very high strength | 4 = very high agility | 4 = very high intelligence | 4 = very high mental fortitude | 4 = very high hardiness | 4 = very high perception | 4 = functionally immortal | 4 = moderate to high magical aptitude | 4 = moderate to high psychic aptitude |
|  | 3 = average human | 3 = stocky and muscular | 3 = green or grey skin tones |  |  | 3 = varies among members of group | 3 = varies among members of group | 3 = varies among members of group | 3 = varies among members of group | 3 = rolling | 3 = no eyes |  | 3 = no teeth |  |  | 3 = no ears | 3 = elongated |  | 3 = characteristic |  |  | 3 = sexually monomorphic | 3 = highly attractive | 3 = high strength | 3 = high agility | 3 = high intelligence | 3 = high mental fortitude | 3 = high hardiness | 3 = high perception | 3 = very long-lived (thousands of years) | 3 = moderate magical aptitude | 3 = moderate psychic aptitude |
| Table 1. List of physiological character traits and numerically-coded associated states used to score the character- |  | 2 = slightly shorter than average human | 2 = lean and muscular | 2 = full range of human skin tones | 2 = exoskeleton | 2 = elongated | 2 = terminate in claws/scythes | 2 = 4 digits per limb | 2 = no | 2 = digitigrade | 2 = limbless | 2 = glowing, energy-infused eyes | 2 = no | 2 = sharpened teeth | 2 = no | 2 = no | 2 = pointy | 2 = slightly elongated | 2 = no | 2 = minimal | 2 = no | 2 = asexual | 2 = sexually dimorphic | 2 = moderate to highly attractive | 2 = moderate to high strength | 2 = moderate to high agility | 2 = moderate to high intelligence | 2 = moderate to high mental fortitude | 2 = moderate to high hardiness | 2 = moderate to high perception | 2 = long-lived (hundreds of years) | 2 = low to moderate magical aptitude | 2 = low to moderate psychic aptitude |
| **Scores** | 1 = 1 ft or more shorter than average human | 1 = lean and lithe | 1 = human fair skin tones | 1 = endoskeleton | 1 = globose human-like | 1 = terminate in digits | 1 = 5 digits per limb | 1 = yes | 1 = plantigrade | 1 = legged | 1 = physical, human-like eyes | 1 = yes | 1 = flat teeth | 1 = yes | 1 = yes | 1 = lobed like humans | 1 = human-lengthed | 1 = yes | 1 = none | 1 = yes | 1 = sexual | 1 = androgynous | 1 = unattractive | 1 = low to moderate strength | 1 = low to moderate agility | 1 = low to moderate intelligence | 1 = low to moderate mental fortitude | 1 = low to moderate hardiness | 1 = low to moderate perception | 1 = short-lived (human lifespan or less) | 1 = none | 1 = none |
| **Physiological Traits** | Height | Body Type | Skin Tone | Skeletal Structure | Cranium | Type of Forelimbs | Number of Forelimb Digits | Opposable Thumbs Present | Type of Legs | Type of Locamotion | Type of Eyes | Mouth Present | Type of Teeth | Tusks Present | Ears Present | Ear Shape | Ear Length | Hair Growth on Head | Facial/Body Hair | Nose Present | Reproduction | Sexual Appearance | Attractiveness | Strength | Agility | Intelligence | Mental Fortitude | Hardiness | Perception | Longevity | Magical Aptitude | Psychic Aptitude |

*Trait Categorical Descriptions*

The 70 character traits used in this study were divided up into three categories, *physiological* traits, *behavioral* traits and *archetypal* traits, each of which warrants some additional elaboration here. The physiological category consists of traits that characterize physical descriptions of typical members of a given fictional race/taxon. Examples include physical characteristics such as the typical height of taxon members, the type of physical locomotion they utilize to move around in 3D space, the presence and type of, or absence, of physical features such as ears and hair, traits associated with physical or mental performance such as strength and intelligence of typical taxon members, as well as traits related to fictionally established physiology such as longevity and aptitude for supernatural expression.

The behavioral category consists of traits that characterize some generalized behaviors associated each fictional race as a whole. Some examples include behavioral adaptability of typical taxon members, referring to the ability of individuals to adapt or adjust their general thinking and/or behavior to different circumstances, a race’s typical attitude toward matters of foreign policy, the general

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| associated states used to score character-state matrix. Scores of matrix were used as sequence alignments for phylogenetic inference. |  |  |  |  |  |  | 5 = feral |  |  |  | 5 = invasive |  |  |  |  | 5 = very high |  | 5 = not expressed | 5 = not expressed | 5 = not expressed |  |
|  | 4 = highly adaptable | 4 = extremely adaptable | 4 = tolerant | 4 = highly aggressive |  | 4 = exquisite |  | 4 = severe exploitation | 4 = highest grade | 4 = war and conquest | 4 = prescient |  | 4 = hive mind | 4 = display all-consuming spirituality | 4 = moderate to high |  | 4 = excessively so | 4 = excessively so | 4 = excessive | 4 = none expressed |
|  | 3 = adaptable | 3 = highly adaptable | 3 = moderate or grudging tolerance | 3 = moderate to high aggression | 3 = easily provoked into aggression | 3 = high to very high | 3 = high engagement | 3 = high exploitation | 3 = high grade | 3 = trade, commerce and conquest | 3 = moderate to high levels | 3 = moderate to high impulsivity | 3 = socially interconnected | 3 = display broad spirituality | 3 = low to moderate | 3 = form no familial bonds | 3 = overly so | 3 = overly so | 3 = overt | 3 = overtly expressed |
|  | 2 = somewhat adaptable | 2 = adaptable | 2 = low tolerance | 2 = low to moderate aggression | 2 = provoked into aggression on threat | 2 = moderate to high | 2 = moderate engagement | 2 = moderate exploitation | 2 = moderate grade | 2 = trade and commerce | 2 = low to moderate levels | 2 = low to moderate impulsivity | 2 = lean toward social dependence | 2 = display some spirituality | 2 = low | 2 = form strong familial bonds | 2 = moderately so | 2 = moderately so | 2 = moderate | 2 = openly expressed |
| Table 2. List of behavioral character traits and numerically-coded | **Scores** | 1 = rigid | 1 = somewhat adaptable | 1 = near zero tolerance | 1 = low aggression | 1 = not easily provoked into aggression | 1 = basic to moderate | 1 = low ingagement | 1 = low exploitation | 1 = low grade | 1 = isolationists | 1 = none | 1 = low impulsivity | 1 = lean toward individual independence | 1 = none | 1 = none | 1 = form loose familial bonds | 1 = minimally | 1 = minimally | 1 = minimal | 1 = subtly expressed |
| **Behavioral Traits** | Behavioral Adaptability | Environmental Adaptability | Tolerance of Other Races | Aggression | Incitable Aggression | Martial Prowess | Explorative | Environmentally Exploitative | Craftsmenship | Foreign Policy | Prescience | Impulsivity | Sociality | Spirituality | Scholarship | Familial Bonds | Hedonistic | Sadistic | Curiosity | Joviality |

level of expression of individualistic behaviors such as joviality, impulsivity and sadism, general level of engagement in sociality and the formation of familial bonds, and engagement in practical behaviors such as martial training, crafts and predicting future events.

The archetypal category encompasses character traits and states that describe how a race fits into a particular universe in terms of the stories that are told within them. For example, in Tolkien’s stories the orcs fill the role of an irredeemably evil race of vile killers who serve as a persistent villainous army that threatens the noble races of the world. In another universe, the Warcraft universe, the orcs are initially presented as a race occupying a similarly villainous story role, but are later revealed to actually be a noble race themselves who are only pitted against the protagonist races circumstantially. These adjustments to the original archetypes are part of the evolution of these races across fiction, and thus an attempt has been made here to include these considerations in the proposed analysis. Some examples of archetypal traits featured in the present study include racial age, or how long the group has inhabited the fictional world, contemporary demographic prevalence, role in storytelling, and racial origin/creation.

The states and scoring for these traits, across all three categories, was accomplished with the understanding that individuals of any given fictional group can and do vary dramatically from what their collective race may have been scored as here for a given trait; scoring for these traits was meant to reflect broad generalities that are often used to describe these races in either their source material or in supplemental secondary material found on the internet.

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| matrix. The scores of the matrix were used as sequence alignments for phylogenetic inference. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 6 = biological |  |  |
|  | 5 = "force of nature" |  | 5 = rare or extinct |  |  | 5 = hyper advanced tech |  |  | 5 = background lore |  |  |  |  |  |  | 5 = hyper advanced |  |  |
|  | 4 = evil |  | 4 = fading | 4 = influential to security | 4 = deep connection to nature | 4 = highly advanced teched | 4 = hyper evolved or created | 4 = highly susceptible | 4 = secondary focus (villainous) | 4 = often associated with | 4 = martial (biological) | 4 = unknown |  | 4 = all-consuming | 4 = seek to defeat and assimilate enemies | 4 = highly advanced | 4 = sweepingly grand | 4 = unassociated with particular habitat |
|  | 3 = antagonistic | 3 = young; "upstart" | 3 = uncommon | 3 = highly influential | 3 = high connection to nature | 3 = moderate to high tech | 3 = highly evolved or created | 3 = susceptible | 3 = primary focus (villainous) | 3 = often entangled | 3 = martial (technological & supernatural) | 3 = created by another race via tech or magic | 3 = seek to consume their environment | 3 = excessively motivated | 3 = seek to defeat and subjugate enemies | 3 = advanced | 3 = grand | 3 = underground or within mountains |
| Table 3. List of archetypal character traits and numerically-coded associated states used to score the character-state |  | 2 = pragmatic | 2 = middle aged; "long established" | 2 = moderately common | 2 = in some respects | 2 = some connection to nature | 2 = low to moderate tech | 2 = moderately evolved or created | 2 = somehwat susceptible | 2 = secondary focus (protagonists) | 2 = sometimes entangled | 2 = martial (supernatural) | 2 = product of evolution | 2 = seek to control their environment | 2 = moderate to highly motivated | 2 = seek to defeat and exterminate enemies | 2 = moderate | 2 = expansive | 2 = in forests and woods |
| **Scores** | 1 = noble | 1 = ancient; "first born" | 1 = common | 1 = minimally | 1 = none | 1 = low tech | 1 = primitively evolved or created | 1 = insusceptible | 1 = primary focus (protagonists) | 1 = rarely entangled | 1 = martial (technological) | 1 = divinely created or manipulated | 1 = seek harmony with their environment | 1 = minimally motivated | 1 = seek to defaet and hault enemies | 1 = basic | 1 = minimalist | 1 = in the open world |
| **Archetypal Traits** | Conflict Role | Racial Age | Prevalence | Culturally Influential | Connection to "Nature" | Technological Advancement | Biological Advancement | Corruptability | Story Role | Prophecy Entanglement | Threat Type | Creation | Broad Motivation | Economic Motivation | Domination Motivation | Architectural Design | Architectural Scope | Associated Homeland Habitat |

*Maximum Likelihood Analyses*

A set of ML analyses were conducted using the program *RaxML* in order to approach addressing two questions; how much have iterations of Tolkien’s fantasy races changed across different IPs, and have they changed, if at all, more or less so with respect to one of the trait categories over the others? To get at the first question, character state sequences extracted from the trait scoring matrix from all three trait categories were concatenated for each taxa, and all 36 concatenated sequences were aligned for use in two analyses conducted in *RaxML*: (1) search of the tree space of possible topologies for the data and identification of the best tree; (2) calculation of bootstrap support values for tree nodes. Option details for the commands used in *RaxML* to run the former are as follows.

A total of 400 likelihood trees were searched (--tree pars{200},rand{200}) using a multistate model with an 8 state ceiling and equal rates of change for all possible state changes (--model MULTI8\_MK). The ‘MULTI8’ model was necessary to run this alignment because one of the physiological traits (skin tone; see Table 1) was coded with 7 possible states; in order for *RaxML* to run a multistate analysis, the model must be set to a maximum number of states that is greater than the total number of unique states that appear in the dataset by at least one. The ‘\_MK’ designates the model as having equal rates of change for all possible state changes. This was used because the assumption was made that in reality creators are essentially free to make whatever changes they want to Tolkien’s archetypes for use in their own IPs; nothing technically restricts them from doing so. Three taxa from the alignment were designated as outgroups (--outgroup Zerg\_OG,Tyranids\_OG,Xenomorphs\_OG) to root trees found in the search. Originally the ‘Protoss\_OG’ taxon was intended to be used as an outgroup in addition to the other three, but *RaxML* was unable to root trees in the search when that sequence was included as an outgroup.

Tree node support values were calculated by a non-parametric bootstrap analysis performed with 1000 replicates (--bs-trees 1000), using the same outgroup assignments and multistate model as in the tree search analysis above. Convergence of bootstraps was checked post-analysis using the --bsconverge command in *RaxML*. The default cut-off value for MRE-based bootstopping tests performed by the program during convergence testing was used.

To attempt to gain an idea of how the taxa used in this study have changed comparatively between the three trait categories (physiological, behavioral and archetypal), matrix score sequences for traits from each category were aligned separately and analyzed in a similar manner as described for the concatenated alignment above, except that the multistate model utilized was adjusted appropriately depending on the alignment (while the physiological traits alignment featured a total of 7 state variables, the behavioral and archetypal alignments contained a total of 5 and 6 state variables, respectively). Additionally, the outgroups that were included were adjusted as well. *RaxML* was unable to root trees during tree searches for any of the single category alignments when any combination of the four outgroup taxa were designated as such. The program was only able to root trees searched when a single taxon was designated as the outgroup for each alignment. As a result, ML analyses were conducted on two sets of single-category alignments, each set with a different designated single taxon outgroup.

Of the four fictional races chosen for this study to serve as outgroups, the Zerg, Tyranids and Xenomorphs taxa are all very similar to one another across a majority of the character traits scored. Therefore, one of these taxa (Zerg) was chosen to be the sole outgroup for the first set of single-category alignments (Tyranids\_OG, Xenomorphs\_OG and Protoss\_OG sequences were removed from these alignments entirely). For the second set of single-category alignments, the

Table 4. Taxa and character state sequence data used in this study. Taxa are grouped according to the fictional universes they are from. Reading from left to right along the sequences, positions 1 – 32 correspond to physiological traits from Table 1, in order from *Height* to *Psychic Aptitude*; positions 33 – 52 correspond to behavioral traits from Table 2, in order from *Behavioral Adaptability* to *Joviality*; positions 53 – 70 correspond to archetypal traits from Table 3, in order from *Conflict Role* to *Associated Homeland Habitat*

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| **Intellectual Property (IP)** | **Taxa** | **Character State Sequences** |
|
| **Lord of the Rings (LotR)** | **Humans\_LotR** | **3 2 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 1 2 2 1 2 1 3 2 4 3 2 2 2 3 2 3 1 3 2 2 4 2 2 1 3 2 1 3 1 3 1 2 2 4 1 3 1 1 2 2 1 2 2 1** |
| **Elves\_LotR** | **4 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 3 1 3 3 2 1 3 4 4 1 1 1 2 2 1 3 1 1 4 1 2 1 1 3 5 1 1 1 2 1 1 1 4 1 4 3 3 2 2 4 3 1 1 1 1 3 1 2** |
| **Dwarves\_LotR** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 1 1 3 2 2 3 3 2 2 3 1 2 2 3 3 1 2 3 2 3 2 1 2 2 2 4 2 2 1 3 2 1 2 3 2 2 3 3 1 2 1 1 1 1 3 1 3 3 3** |
| **Orcs\_LotR** | **1 2 3 1 1 1 1 1 1 1 1 1 2 2 1 2 2 1 2 1 1 1 4 3 2 1 1 3 2 2 2 1 1 3 1 4 3 2 1 4 1 4 1 3 2 1 1 1 1 3 1 4 3 2 2 4 1 1 1 4 4 1 1 1 2 1 2 1 2 1** |
| **The Forgotten Realms (FR)** | **Humans\_FR** | **3 2 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 2 2 2 1 5 1 3 2 3 3 2 2 2 3 2 3 2 2 2 3 4 2 2 2 3 2 1 3 1 3 2 3 2 3 1 2 3 2 2 2 1 2 2 1** |
| **Elves\_FR** | **2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 3 1 3 2 2 1 3 2 5 1 2 2 3 2 1 2 2 2 3 2 2 3 2 3 4 1 2 1 3 3 1 1 3 2 3 2 3 3 1 2 3 1 2 2 1 2 1 1** |
| **Drow\_FR** | **2 1 4 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 2 2 1 3 3 2 1 3 2 5 1 2 1 2 3 3 3 2 2 3 3 2 3 1 3 4 1 3 3 2 1 3 1 3 2 2 3 3 3 4 2 3 1 2 3 3 3 2 3** |
| **Dwarves\_FR** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 1 3 2 2 3 3 3 2 2 1 2 2 3 3 2 2 2 2 3 2 2 2 2 2 3 2 2 1 3 2 1 1 3 2 2 3 3 2 1 2 3 1 2 3 1 3 3 3** |
| **Orcs\_FR** | **3 4 3 1 1 1 1 1 1 1 1 1 2 1 1 2 2 1 3 1 1 1 4 3 2 1 1 3 1 1 2 1 1 2 2 3 3 2 1 2 1 4 1 3 2 1 1 1 1 3 1 1 3 2 2 4 1 1 1 4 4 2 1 2 2 1 3 1 1 1** |
| **The Elder Scrolls (ES)** | **Humans\_ES** | **3 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 2 2 2 1 5 1 3 2 3 3 2 2 2 2 2 3 2 2 2 3 4 2 2 2 2 2 2 3 1 3 1 2 2 3 1 2 3 2 2 2 1 2 2 1** |
| **Altmer\_ES** | **4 2 5 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 2 1 1 1 3 2 3 3 2 2 3 3 5 1 2 2 3 2 2 2 1 1 2 2 2 2 2 3 4 1 2 1 3 2 2 1 3 2 2 3 3 2 1 2 3 2 2 2 1 3 1 1** |
| **Dunmer\_ES** | **3 2 4 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 2 1 1 2 2 1 3 2 2 1 3 3 5 1 2 1 2 3 3 2 1 1 2 3 2 3 1 3 4 1 2 2 2 1 3 1 3 2 2 3 3 3 1 2 3 2 2 2 1 2 1 1** |
| **Dwemer\_ES** | **3 2 4 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 3 1 1 2 2 1 2 4 2 1 2 2 5 1 2 2 2 2 1 2 2 1 4 1 2 1 2 2 5 2 1 1 4 1 1 1 5 1 2 4 3 2 5 1 3 2 2 1 1 4 3 3** |
| **Orsimer\_ES** | **4 3 3 1 1 1 1 1 1 1 1 1 2 1 1 2 2 1 3 1 1 2 1 3 2 2 3 3 2 2 5 1 3 2 3 3 3 3 1 2 3 3 2 3 1 3 3 2 2 2 2 2 2 2 2 2 1 2 2 3 1 2 3 2 2 1 1 1 1 1** |
| **Warcraft (WC)** | **Humans\_WC** | **3 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 2 2 2 1 5 1 3 2 4 3 2 2 2 3 2 3 2 3 2 3 4 2 2 2 3 2 1 3 1 3 1 3 2 3 1 2 3 2 2 2 1 3 2 1** |
| **Night\_Elves\_WC** | **5 2 4 1 1 1 1 1 1 1 2 1 1 2 1 2 4 1 3 1 1 2 3 2 3 3 2 2 4 3 4 1 2 1 3 2 1 3 1 1 2 1 3 1 1 2 4 1 1 1 2 1 1 1 3 2 4 2 3 2 1 2 3 1 1 1 1 2 1 2** |
| **High\_Elves\_WC** | **3 1 1 1 1 1 1 1 1 1 2 1 1 2 1 2 3 1 2 1 1 2 3 1 3 3 2 1 3 3 4 1 2 1 3 2 2 2 1 1 3 2 3 2 2 2 4 1 2 2 4 1 1 2 2 2 2 2 3 3 2 1 3 2 2 1 1 4 1 2** |
| **Dwarves\_WC** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 1 3 2 2 3 3 2 2 5 1 3 2 4 3 2 2 3 2 4 2 2 2 2 2 4 2 2 1 4 3 1 2 2 3 2 3 3 2 2 1 3 1 1 3 1 4 3 3** |
| **Orcs\_WC** | **4 4 3 1 1 1 1 1 1 1 1 1 2 1 1 2 2 1 3 1 1 2 1 3 2 2 2 3 2 1 5 1 3 2 3 3 3 3 2 3 2 3 3 3 2 3 3 2 2 2 2 2 1 3 1 3 2 2 3 3 1 2 3 2 2 2 1 2 2 1** |
| **Warhammer (WH)** | **Humans\_WH** | **3 2 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 1 2 2 1 2 1 3 2 2 3 2 2 2 3 2 3 2 3 2 3 4 2 2 2 3 2 2 3 1 3 1 2 2 4 1 3 3 3 2 2 1 2 2 1** |
| **High\_Elves\_WH** | **4 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 3 1 3 3 2 1 3 3 4 1 2 1 2 3 2 3 1 1 3 1 3 2 2 3 5 1 1 1 2 1 1 1 3 1 2 3 3 2 2 4 3 3 2 1 1 3 2 1** |
| **Dark\_Elves\_WH** | **4 1 4 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 2 1 3 3 2 1 3 3 4 1 2 1 2 3 3 3 2 3 3 4 3 3 1 2 3 3 4 4 3 3 4 1 2 4 1 3 3 4 4 2 3 3 2 3 3 3 2 1** |
| **Dwarves\_WH** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 1 3 2 2 3 3 2 2 2 1 3 2 2 3 2 3 2 2 4 1 2 2 2 2 4 2 2 1 3 1 1 1 2 2 2 3 3 2 2 1 3 3 2 2 1 4 3 3** |
| **Orcs\_WH** | **4 4 3 1 1 1 1 1 1 1 1 1 2 1 1 2 2 2 1 1 2 3 4 4 2 1 1 3 1 3 2 2 1 3 1 4 3 5 1 3 1 4 1 3 3 2 1 3 5 3 1 4 5 2 1 4 1 1 3 1 4 1 3 3 3 1 2 1 1 1** |
| **Warhammer 40K (40K)** | **Humans\_40K** | **3 2 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 1 1 3 2 1 2 1 1 5 2 2 1 3 3 1 2 4 3 4 2 3 2 4 3 1 2 2 3 1 3 3 1 3 1 4 2 4 1 3 3 3 2 3 2 4 4 4** |
| **Eldar\_40K** | **4 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 3 2 3 4 3 2 4 3 1 4 1 1 1 3 2 4 1 1 4 1 4 2 2 2 5 1 1 1 2 1 3 1 4 1 1 5 3 2 2 4 3 3 2 1 2 5 4 4** |
| **Dark\_Eldar\_40K** | **4 1 4 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 2 2 3 4 3 2 4 3 1 4 1 1 1 4 3 4 2 2 4 4 4 3 1 2 4 3 4 4 4 3 4 1 3 4 1 5 3 4 4 2 3 3 2 3 3 5 4 4** |
| **Squats\_40K** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 1 2 2 3 2 2 2 2 1 5 2 2 1 3 2 2 2 3 3 2 2 2 2 3 4 2 2 1 3 1 2 3 5 1 1 4 2 2 5 1 3 3 2 3 2 4 3 3** |
| **Orks\_40K** | **4 4 3 1 1 1 1 1 1 1 1 1 2 1 1 2 2 2 1 1 2 3 4 4 2 1 1 3 1 3 2 2 1 3 1 4 3 5 1 3 2 4 1 3 3 2 1 3 5 3 1 4 5 2 1 4 1 3 3 1 4 1 3 3 3 1 2 1 1 4** |
| **The Witcher (W)** | **Humans\_W** | **3 2 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 2 2 2 2 2 2 2 1 5 1 3 2 3 3 2 2 2 3 2 3 1 2 2 2 4 2 3 2 2 2 2 3 1 3 1 3 2 3 1 3 3 2 2 2 3 2 2 1** |
| **Elves\_W** | **2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 1 1 1 1 1 3 1 3 2 2 1 3 2 5 1 3 2 3 2 1 2 2 1 3 2 1 2 2 2 3 1 3 1 2 2 2 1 3 2 2 2 2 3 2 4 3 2 2 2 1 1 1 2** |
| **Dwarves\_W** | **1 3 2 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3 1 1 2 1 2 1 2 2 2 2 2 2 1 3 2 4 3 2 2 2 2 3 2 1 2 2 2 4 2 2 1 2 2 2 1 3 2 2 2 2 3 2 1 3 2 2 2 1 2 1 1** |
| **Outgroups (OG)** | **Protoss\_OG** | **5 1 4 1 2 1 2 1 2 1 2 2 3 2 2 3 5 2 1 2 1 2 2 3 3 4 2 2 3 3 1 4 2 2 2 3 2 3 1 2 4 1 3 2 3 2 5 1 1 1 3 1 1 1 1 4 1 5 3 2 1 3 3 3 2 2 1 5 4 4** |
| **Zerg\_OG** | **6 5 7 2 2 3 3 2 3 4 2 1 2 2 2 3 5 2 1 2 2 3 4 4 4 1 3 4 3 4 1 2 1 4 1 4 3 5 2 4 1 5 1 3 4 1 1 3 5 5 5 4 5 2 1 4 1 1 4 3 3 3 4 3 3 4 4 6 2 4** |
| **Tyranids\_OG** | **6 5 7 2 2 3 3 3 3 4 2 1 2 2 2 3 5 2 1 2 2 3 4 4 4 1 3 4 3 5 1 2 1 4 1 4 3 5 2 4 1 5 1 3 4 1 1 3 5 5 5 4 5 2 1 4 1 1 4 1 4 4 4 4 3 4 4 6 2 4** |
| **Xenomorphs\_OG** | **5 1 6 2 2 1 3 1 2 1 3 1 2 2 2 3 5 2 1 2 2 3 4 4 4 1 2 3 4 5 1 1 1 3 1 4 3 5 1 4 1 5 1 3 3 1 1 3 5 5 5 4 5 2 1 4 1 1 3 1 3 1 4 3 3 4 4 6 2 4** |

Protoss\_OG taxon was designated as the outgroup and sequences from the other three outgroup taxa were removed from the alignments. This replication was done in part because it was difficult to decide which of the four taxa would work best as the single outgroup for the rest of the dataset, and in part simply to see how using two different outgroups would affect the resulting tree topologies. Together with the concatenated alignment run, a total of 9 ML analyses were conducted on datasets for this study.

RESULTS

*Analyses of Concatenated Alignment*

Maximum likelihood trees, with mapped-on bootstrap support values, generated from the concatenated character state alignment are shown in Figures 1 – 3. Figure 1 shows the ML tree resulting from the analysis of the concatenated alignment where 3 taxa (Zerg\_OG, Tyranids\_OG and Xenomorphs\_OG) were designated as outgroups. The tree topology recovered all of the elven taxa as monophyletic. Of the 7 IPs that were included in this study, 4 of them utilize the relatively common trope in fantasy and science-fantasy of incorporating the presence of ‘dark’ elves in the fictional universe; dark elves are often portrayed as a villainous group, the opposite of their virtuous elven counterparts. In the Figure 1 phylogeny, all the dark elven taxa formed a monophyletic clade. While all elves grouped together, the remaining, non-dark elven taxa did not form a monophyletic clade. Interestingly, the Protoss\_OG taxon, though originally intended as an outgroup and although not a race of elves, claded within that group. Another Tolkien-derived fictional race that grouped together were the dwarves. Dwarves from across all IPs formed a paraphyletic clade, and this clade was sister to the elven clade in the tree topology. The elf-dwarf clade came out as sister to the polyphyletic humans. All human taxa except one (Humans\_40K) nested within a clade sister to the elves and dwarves; the Humans\_40K taxon from the *Warhammer 40K* universe ended up being nested within the dwarven clade, sister to the Squats (the dwarves of the same universe). The orc taxa, like the dwarves, were also paraphyletic, although spread out on the tree topology rather than forming an inclusive clade.

Figure 2 shows the ML tree that resulted when all four intended outgroup taxa (Protoss\_OG, Zerg\_OG, Tyranids\_OG and Xenomorphs\_OG) were designated as outgroups in the tree search and bootstrap analyses. With respect to the human, dwarven and elven taxa, the tree topology was the same as resulted from the previous analysis described above; dark elves and elves as a whole were monophyletic and sister to the paraphyletic dwarves, and these two clades together were sister to the polyphyletic humans. Where additionally designating the Protoss\_OG taxon as an outgroup changed the tree topology (at least at a glance) as compared to the previous analysis was in the placement of the orcish taxa; rather than clading with the other three sets of Tolkien-derived taxa, the orc taxa claded with the other three outgroup taxa (Zerg\_OG, Tyranids\_OG and Xenomorphs\_OG) and were collectively sister to the former. Even though the Protoss\_OG taxon was assigned as an outgroup here, it still ended up being nested within the elven clade as it was in the previous analysis; since the outgroups did not form a monophyletic group, *RaxML* was unable to root the tree based on the outgroups. Given that the tree in Figure 2 is unrooted, the relationships suggested by the tree topology are actually the same as the tree shown in Figure 1.

What *did* change the relationships depicted by the tree topology resulting from the concatenated dataset was removing the Zerg\_OG, Tyranids\_OG and Xenomorphs\_OG taxa from the alignment and designating the Protoss\_OG taxon as the sole outgroup in the analysis. Figure 3 shows the resulting tree; the similarities in character states between the Protoss\_OG taxon and the elven taxa caused the monophyly of the latter to be broken up, and dragged the previous elven clade out of its position as sister to the dwarves. In this topology, the elves are paraphyletic and basal to both the dwarves and humans. The change in outgroup also shifted the placement of the orcs; rather than being basal as in the previous trees, the orcs came out here as more derived, and sister to the humans.

Bootstrap support values across all three of the trees described above were overall low except in a few cases. The relationships suggested among the orc taxa were well supported in these analyses, with nodes being supported between 70 and 100 percent of the time across all bootstrap replicates. In the two instances they were utilized, the relationships among the Zerg\_OG, Tyranids\_OG and Xenomorphs\_OG outgroup taxa were also strongly supported. In the first two trees shown in Figures 1 and 2, the clade containing all the elves, dwarves and humans was moderately supported at 65 percent bootstrap support. All other nodes were poorly of very poorly supported.

*Analyses of Categorical Alignments*

The categorical character state alignments were problematic to assess. Of the six ML analyses attempted on these datasets (see Table 5), two of them (both behavioral alignment analyses) failed to complete the tree search due to persistent errors encountered in *RaxML* that were unable to be resolved. A third analysis (of the physiological alignment with the Zerg\_OG taxon as outgroup) persistently failed to complete the bootstrap assessment due to an error terminating the process as well. No issues running the program were encountered throughout assessment of the concatenated sequence alignment, so the issue may have been related to the small sequence size of the categorical alignments. Nonetheless, analysis of some of the categorical alignments was completed and the results of two of them are described here.

Since both runs of the archetypal sequence alignment were completed successfully, their resulting trees are described and can be seen in Figure 4. In general, the tree topologies were affected similarly by their respective designated outgroups as in the analyses described for the concatenated alignment. In the archetypal alignment where the Zerg\_OG taxa was set as the outgroup, the orc taxa were more basal and the elves more derived, with the opposite being the case when the Protoss\_OG taxon was made to be the outgroup. Other than that, limiting the dataset to just the archetypal alignment did affect the tree topology somewhat compared to the concatenated dataset. In the tree from the Zerg\_OG alignment, the elven and dwarven taxa formed an inter-mixed clade, which placed as sister to a clade that this time contained all the human taxa; although humans all grouped together archetypally, they were still paraphyletic as one of the orc taxa (orcs from the *Warcraft* universe) nested within that clade as well.

Similarly, the humans all grouped together in the topology for the tree built from the archetypal alignment with Protoss\_OG set as outgroup. The elf-dwarf clade was broken up however by the outgroup assignment, the two sets of taxa spread out across the basal half of the tree.

Bootstrap support values for nodes of these trees were even lower than in the trees for the concatenated alignment; nearly all nodes had less than 70 percent support.

DISCUSSION

The tree topologies resulting from the analyses of the concatenated sequence alignment suggest that despite alterations creators have made to their versions of Tolkien’s iconic fantasy races, most of these fictional peoples have not changed substantially across the IPs investigated to prevent them from forming phylogenetic clades based on race when considering all the character traits utilized in this study. The one exception was the orcish taxa, who did not form distinct clades except when the designated outgroup was the Protoss (discussed further below). The long branches separating subsets of the orc taxa are likely due to substantial creative shifts that have been made by IP producers in terms of the archetypes and behaviors characterizing their brand of orcs. For example, the orcs of the *Elder Scrolls* and *Warcraft* IPs (Orsimer\_ES and Orcs\_WC, respectively) are much more humanistic than orcs portrayed in other intellectual properties. They have families, form emotionally bound communities, and often fight for causes other than the shear desire to express violence and engage in bloodlust; these departures from the vile and retched orcs of Tolkien and others have resulted in the placement of these taxa as sharing a more recent common ancestor with elves, dwarves and humans than with other orcs. Conversely, the more antagonistic and villainous orc taxa shared more recent common ancestors with the monstrous horrors of the Zerg, Tyranid and Xenomorph outgroups, all three of which are characterized as large, physically powerful and overwhelmingly deadly insectoid creatures who stop at nothing to dispatch their foes.

The exception for orcs not appearing to form distinct clades was when the Protoss where designated as the sole outgroup in an analysis. A bi-pedal, psionically adept alien race from the *Starcraft* science-fiction universe, the Protoss, despite being the product of a different genre in fiction with many physiological traits that differ substantially from the Tolkien-derived elf variants, share much of their design as a fictional people in terms of behavior and story roles with that of the elves. Their behavioral and archetypal trait states are shared so much so that whenever the Protoss are assigned as the outgroup in an alignment it causes all the elven taxa to shift on the tree topology from a derived monophyletic group to a basal paraphyletic group. This shift additionally alters the placement of the orc taxa in the phylogenies. The orcs and the elves were consistently the most distantly related groups out of the Tolkien four, indicating they shared the least amount of character states overall. As a result, a shift of the elven taxa to a more basal position on the trees when the Protoss were used as the outgroup always shifted the orc taxa to more derived positions. In the trees where this was the case, the orcs would appear to be monophyletic. However, given the degree of similarity between the Protoss and the elves it seems reasonable to determine that the Protoss do not serve well as an outgroup for the set of taxa used in this study. The greater dissimilarity between the Zerg, Tyranids and Xenomorphs relative to the rest of the dataset made these taxa more suitable, hence the tree from Figure 1 is here the preferred representation of the present data in terms of maximum likelihood inference.

The inferred tree topology suggests that elves, dwarves and humans from across seven different fictional universes share more in common with their respective cross-universe variants than they do with each other, but the tree nodes representing these relationships were for the most part poorly supported in the bootstrap analyses. Although the preferred tree topology from the concatenated sequence alignment suggests an interesting conclusion about the general fidelity of content creators to the origins established by Tolkien, the present study was unable to show strong statistical support for the relationships inferred. An extension of the dataset developed and used here may be necessary to estimate phylogenetic relationships among these fictional races with greater statistical support.

The scope of the present dataset was even more limiting in the case of the assessment of the categorical sequence alignments. Although this study was unable to compare sets of tree topologies generated from each categorical sequence alignment based on different outgroups, the topologies successfully generated from the archetypal traits alignment, when compared to those generated with the concatenated alignment, hint at the idea that IP creators may be more inclined to bend the Tolkien mold in some categorical ways than others. Future phylogenetic studies of the fictional races of Tolkien would likely benefit from an expanded suite of categorical character traits to better assess in what ways IP creators are more or less likely to depart from established source materials.