A Phylogeny and Evolutionary History of the Pokémon

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With the phylogenetic and evolutionary relationships of the kingdoms *Animalia*, *Plantae*, and *Fungi* mostly out of the way, attention is now turning towards the *Monstrasinu*, commonly known as "Pocket Monsters" or "Pokémon" for short. Starting from the 151 original "species" described by Japanese scientist Satoshi Tajiri in a 1996 monograph, Pokémon science today continues to be a rewarding field for taxonomists. Every three to four years, several new species are discovered and described almost simultaneously. A total of 646 Pokémon have been described, most of them in Japan.

This paper represents the first attempt to create a quantitative phylogeny of the Pokémon, using the underlying assumption that Pokémon evolved via natural selection independently from the animals and plants more familiar to Western zoologists. The goal was to apply modern evolutionary theory and techniques to a field previously limited to pre-Darwinian methods of inquiry.

The Need for a Taxonomy

Conservationists have highlighted the importance of documenting extant Pokémon, many of which are known only from single specimens and all of which are threatened by the Pokémon fighting rings that are growing rapidly in popularity, particularly among urban youth.

Further exploration into the world's Pokémon diversity has been limited in part due to disagreements over which species concept to use for the Pokémon, as translations of Tajiri's orginal work used the term "evolution" to describe what should otherwise have been called "metamorphosis." Several sexually dimorphic taxa have had males and females identified as separate species (ex: Nidoqueen and Nidoking), yet these errors remain as Pokémon taxonomists have shown complete resistance to revising the Pokémon taxonomy.

Further complicating the issue is the fact that Pokémon are quite willing to interbreed successfully: the lack of post-zygotic reproductive isolation is one thing, but how a 400--kilogram Wailord is able to mate with an 11-kilogram Skitty at all remains a mystery. The results of the mating are, in at least one respect, puzzling. To our knowledge, no hybrids are created; the interbred offspring are always the same species as the female parent, yet with some traits inherited from the male.

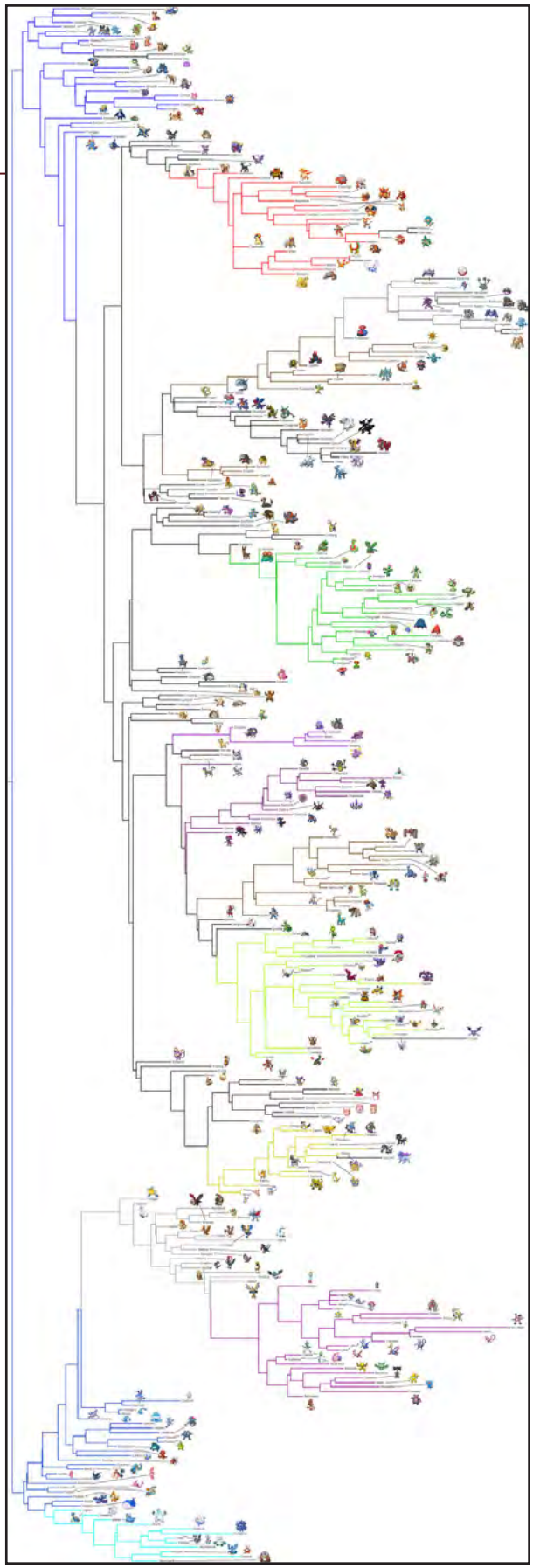

*Figure 1. The phylogeny of all the known Pokémon families. Sexually dimorphic species are labeled with a *. Taxon pairs that represent two possible metamorphosis endpoints for a single species (Ex: Slowpoke can become a Slowbro or a Slowking) are labeled with a **, and if they also represent sexual dimorphisms are labeled with ***.*

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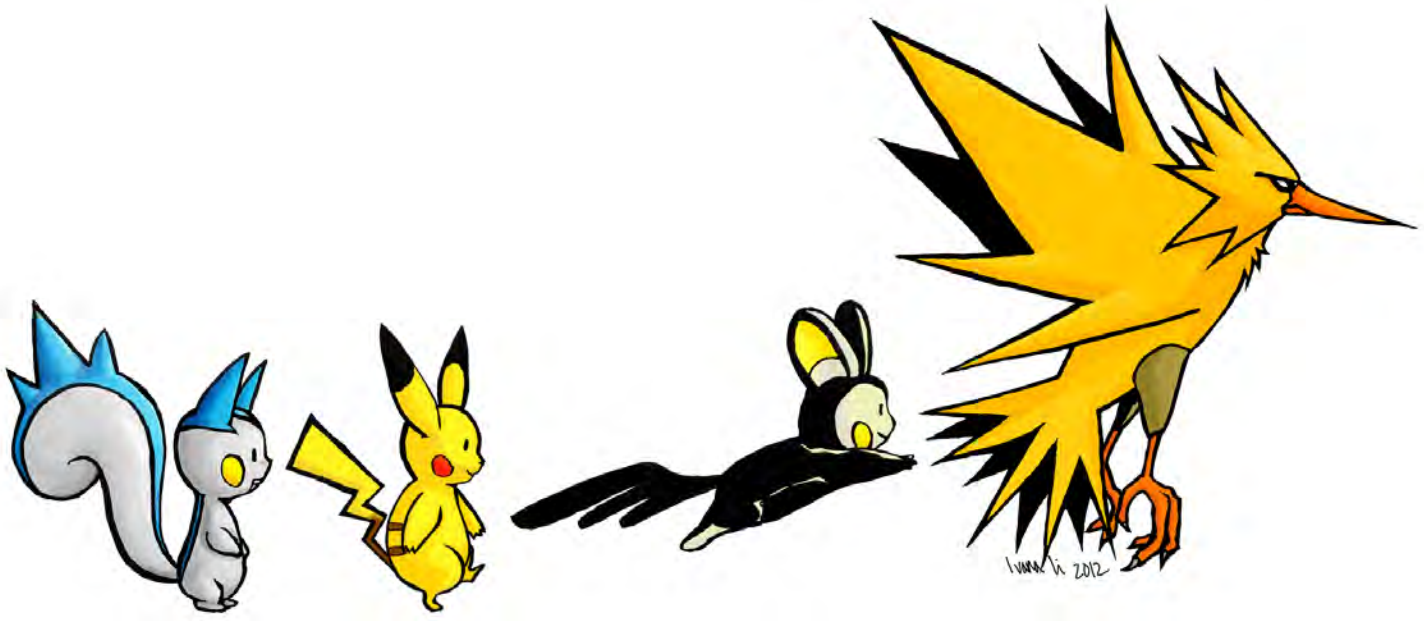

Methods

Wild Pokémon were captured by undergraduate, high school, and primary-school aged interns/trainers from the Kanto, Johto, Hoenn, and Sinnoh regions of Japan, as well as Unova county, New York State. [Disclosure: Trainers may or may not have used their Pokémon for combat during the course of their research.]

For the purposes of the phylogeny, each "taxon" in the study was a single Pokémon "family" (e.g. Pichu, Pikachu, and Raichu are a single taxon). Sexually dimorphic species were kept as two separate taxa as per the traditional taxonomy. Pokémon genetics and molecular biology remains poorly understood, so our cladistic analysis used the following shared characters: Type (e.g. Fire, Water, Bug, Ghost, Fighting, Steel, etc.), Egg group (16 categories limiting which hybridizations are possible), Body Style (14 categories describing general morphology), and moves and abilities. Over 700 moves and abilities are known, and whether a given taxon was capable of learning a move via natural development was the main synapomorphy (shared, derived characteristic) used in our phylogeny. Detailed descriptions of these characters and their official values for each taxon are available at online Pokémon encyclopedias such as the fifth generation National Pokédex[1] and practical, fighting- and breeding-oriented databases[2].

The data was saved as a space-delineated file and converted to a Nexus file using the program Mesquite. The software MrBayes[3] was used to run a Bayesian MCMC (Markov chain Monte Carlo) analysis of phylogeny. The final tree (fig. 1) was a result of 16 million generations of simulated Pokémon evolution.

[1] *http://www.pokemon.com/us/pokedex/*

[2] *http://bulbapedia.bulbagarden.net/*

[3] *http://mrbayes.sourceforge.net/*

Results

The tree, rooted at its midpoint, suggests the following evolutionary history: Pokémon life began in the water, with Pokémon similar to lampreys and bony fishes being among the earliest to reach their present state. Terrestrial life arose independently three times, once with the evolution of the monophyletic Ice types (starting with the semiaquatic Dewgong), and once with the evolution of a major clade of Flying types (starting with the seabird Pelipper). Psychic types are a monophyletic group from within the birds, starting with Xatu, that gradually lose the ability to fly (suggesting Levitation is modified flight). The highly humanoid Mr. Mime appears here, as the most derived and recently evolved taxon. Also appearing here are Pokémon such as Mewtwo and Arceus, of which there are unverified rumors of high cognitive ability, on par or greater than humans. Certain religious sects revere the Pokémon in this clade as deities.

Terrestriality evolves a third time, again among the water-types, and the rest of the Pokémon evolve from this ancestor. These first, fully terrestrial Pokémon are predominantly Normal types, and specialized types such as Grass, Fire, and Electric arise as monophyletic groups at different points, many from clades analogous to similar organisms in *Animalia*. For instance, the Fire types arise from Pokémon with characteristics similar to canines, and the Grass types from hoofed Pokémon similar to ungulates. Steel and Dragon types are both monophyletic groups within the Rock and Ground clade. Fighting and Bug types are sister groups, whose common ancestor is shared with the Ghost/Dark Clade; and their common ancestor is shared with many of the Poison types. Overall, Pokémon of the same type were grouped together, with their moves and abilities determining their position within each group. Egg groups and Body Styles are completely jumbled throughout the tree.

The branch lengths on the tree indicate time. No specific units could be determined, but the relative lengths can be compared. Many of the highly specialized Pokémon with

unique move-sets show a long period of time since their most recent shared ancestor. We hypothesize that transition species between such pairs may await discovery. Long time spans are also seen in cases of convergent evolutions of elemental types independent of their main groups (labeled in fig. 1 with black bars within colored clades). An example is the evolution of Electrode, a pure Electric-type, among the Steel types with its sister taxon, Magnezone, a dual-typed Steel and Electric type. This presents convergent evolution of Electric-type moves and abilities with loss of Steel-type attributes. While it seems improbable that the ability to generate and manipulate electricity across open air could have arisen more than once, evidence suggests it indeed happened in this case, along with many similar situations across the tree.

Discussion

The tree seems to support most hypothesized relationships between the Pokémon taxa, such as the close relationship between Mew and the genetically modified Pokémon, Mewtwo, or the monophyly of several of the Legendary Pokémon groups (ex: Registeel, Regice, and Regirock; Ho-oh and Lugia; or Reshiram and Zekrom). Sexually dimorphic "species" almost always appeared as sister groups, further supporting their lumping as single taxa. Morphologically similar Pokémon also often appear as monophyletic (e.g. the three feline Pokémon, Persian, Purugly, and Liepard). The unusual Pokémon Ditto, which is its own egg group but can successfully breed with any other Pokémon, retains its uniqueness. The Grass-type Pokémon, which spurred furious debate over whether they should be considered Plants or Animals, are shown to be a monophyletic group that evolved from a clade of Normal-type quadrupeds; the half-plant, half-reptile Venusaur appears as the transitional species between these two stages.

The biological species concept does not seem to apply to the Pokémon. Monophyletic groups of Pokémon are more consistently similar to the Pokémon Types than the breeding-related Egg Groups. This jarring disconnect suggests that the transmission of character traits through generations in Pokémon does not happen through the Mendelian genetics we are familiar with today. This paper thus sheds considerable doubt on whether Pokémon use DNA to transmit genetic information, and further suggests the *Monstrasinu* are a unique domain of life.

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