ARTICLE

# Aliens in the Classroom: Fantastical Creatures as Tools in Teaching Biology

NABT BioClub RECOMMENDATION

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**Abstract**

*Creatures from science fiction and fantasy can be used to illustrate key concepts and principles in biology. This article describes a project for a university-level general zoology course wherein the students classify, down to at least the phylum level, "animals" from the Alien Species Wiki (2013). This is an online database of creatures from television, film, literature, and games. The primary challenges that the students faced were overly fantastical hybridizations and assigning reality-based classification mechanisms to fictional beings, but the project is a useful exercise in creativity, knowledge of diagnostic characteristics, and the wonder of discovery of new, previously unexplainable physio-morphologies.*

**Key Words:** *Aliens; science fiction; animals; taxonomy; evolution.*

As shown by the phenomenal success of J. K. Rowling's *Harry Potter* books, Peter Jackson's *Lord of the Rings* films, and Blizzard's *World of Warcraft* games, the fantasy genre has been enjoying a significant resurgence in popularity across media. In the worlds created for these works and for other titles in fantasy and its sister genres science fiction and horror, the myriad creatures that inhabit them have taken center stage. Fantasy's elves and dragons, science fiction's aliens, horror's vampires and zombies have thrilled and fascinated audiences, as much for their sheer otherness as for their fictional physiologies. It is no surprise, then, that publications such as the *Potter* books and *The Spiderwick Chronicles* have been supplemented with field guides to their respective worlds' denizens. James Cameron's sci-fi epic *Avatar* has taken a similar tack with the publication of *Avatar: An Activist Survival Guide*, which discusses the biology of Pandora's fauna and flora.

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This is not entirely a new trend. In the days of the naturalist-philosophers, there were already treatises on various mythical creatures like the manticore, cockatrice, and griffin, accounting for their unique anatomies. Perhaps most famous among these ancient texts is *Natural History* by Pliny the Elder. Biology teachers can certainly take a page out of Pliny's book and use to their advantage the great interest that many students have in the monsters that they read about, watch on screen, or battle for experience points. Aside from tapping into the interests of the students, there are three major advantages to studying the biology of fantastic creatures. First, the students are able to expand their horizons and appreciate the wealth of "specimens" beyond what they see in their laboratories or read about in their science textbooks; they can learn from popular culture, too. Second, they are able to practice and develop their creativity. Marks (1978) has cited these first two factors as benefits to using science fiction in studying biology. Third, they are able to show how much of the basic biological principles they have learned by applying these to theoretical anatomical designs. Bixler (2007) cites this active-learning format as one advantage of using science fiction to teach evolution.

I present here a minor class project that I have incorporated in an undergraduate general zoology course. It uses information from an online database of alien species and tests how much the students have learned in lessons on animal systematics. Table 1 lists some courses in biology and specific topics within them that can benefit from the use of creatures from speculative fiction.

## Background

Courses in comparative anatomy are, in essence, studies of the evolution of body structures and functions. One of the first lessons is usually on biological design: the biophysics and biomechanics of real-life animal forms. Students primarily learn about the probabilities and practicalities of biological designs given Earth's physical laws. For instance: Why are gargantuan animals like Godzilla improbable designs? Why can elephants not fly? Primary considerations in this regard are (1) the trend in the ratio of surface area to volume as an organism grows in size and (2) the weight that can be carried and supported by a skeletal system. A good example to provide here would be the sandworms of Arrakis in the *Dune* series of science fiction books by Frank Herbert. It has been speculated that the 200-m-long sandworm must have a skeletal system made of carbon nanotubes to be able to support its astounding mass (Hechtel, 2008).

In the lesson on chordate and vertebrate evolution, the students will be able to see that the four-limbed morphology of tetrapods is the norm for living vertebrates and finds its origins in the paired fins of their

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**Table 1. Some biology courses and topics with related questions.**

| Course | Topic | Question |
|---|---|---|
| **General Biology** | Origins of life | How could life have begun in the species' home world? |
| | Biodiversity | In our scheme of biological classification, where would this species be placed? |
| **Comparative Vertebrate Anatomy** | Biological design | Is the species' anatomical design probable, given the Earth's physical laws? |
| | Chordate and vertebrate evolution | What type of vertebrate is this species? |
| | | Is the species' design a deviation from the typical vertebrate design? |
| | Organ system evolution | What would the species' organ system/s look like and how would it/they function? |
| **Ecology & Evolution** | Ecological factors as evolutionary forces | How could the species' ecology have shaped its evolution? |
| | Speciation | How could this species have developed from ancestral forms? |
| | Systematics | Where would this species fit in an existing phylogenetic scheme? |
| **Genetics** | Mutations | What genetic mutations could have resulted in the unique anatomy of this species? |
| | Genetic engineering | What methods of genetic engineering (e.g., splicing, cloning, etc.) were employed to produce this species? |

Sarcopterygian ancestors. The feasibility of design of six-limbed animals ("hexapods") like pegasi, griffins, and dragons is then thrown into question. Did these hexapods evolve from tetrapod ancestors? Do hexapods constitute a monophyletic group? The discussion of more fantastical forms like centaurs can also be encouraged here.

Questions on anatomy inevitably touch on the evolution of these unique species, which in turn leads to the study of their ecologies. Using examples from popular culture would be a good opportunity for biology educators to caution their students on misunderstandings about evolution, of which there are many (Futuyma, 2009). One of the most significant ones is the view of evolution as directional, aiming for a particular perfect design (which many are inclined to think are us humans). Another is that disuse of a structure will unavoidably lead to its eventual loss. Both of these flawed interpretations are subtly invoked in the suggestion that the prolemuris of *Avatar*, that primate whose upper two pairs of limbs (it has six, like most of the Pandoran fauna) have incompletely fused, is the evolutionary precursor of the four-limbed Na'vi (Wilhelm & Mathison, 2009). It is a possibility, but the oversimplification offered here should be pointed out. Speciation is one particular aspect of evolution that can greatly benefit from science fiction examples, and H. G. Wells's *The Time Machine*, with its Eloi and Morlocks, is a key text for this purpose (Bixler, 2007).

The ecology of an organism influences its evolutionary fate. The species of speculative fiction have undoubtedly been shaped by their unique environments, from their physico-chemical conditions to the other organisms that they coexist with. *Dune*, recognized as one of the first science fiction works to extensively involve ecology in its plot, is an adequate reference material in this regard. More accessible and more familiar to today's students would be *Avatar*'s Pandora with its bioluminescent plants and intense predation.

A more specialized approach to the organisms is assessing their phylogeny, using Earth-based species and phylogenetic schemes as the basis. By determining the most important taxonomic characters of various speculative species, the students can be made to propose their own classification schemes for these creatures.

## ○ Materials & Methods

The goal of this project for classes in general zoology is to test the students' knowledge of animal taxonomy, which they would have been taught prior to the project's implementation. The students are instructed to go to the Alien Species Wiki (2013) website (http://aliens.wikia.com), which is an online database of creatures from science fiction across various forms of media. There are currently >1000 species on the site. Although they represent the different biological kingdoms, casual observation will reveal that a majority of the species are animals. The class locates the animals in the list for the purpose of classification. When I handled two zoology classes with an average class size of 27 students, I assigned alien species whose names begin with A to M to one class and the rest to the other class. Each class then divided the total number fairly evenly among themselves.

The final output for the project consists of a table showing the classifications made (Table 2) and a pie graph illustrating the distribution of species among the recognized animal phyla. The table should include the following information: (1) the name of the species; (2) the source material (i.e., book, film, television show, etc.); (3) the speculated classification (down to the taxonomic level of phylum, at least); (4) a justification for the classification; and (5) the name of the student who classified each animal. The pie graph is generated to show which phylum is most heavily represented in the database. Although this database is nowhere near complete, the trends seen here could be a good indication of what animal phylum is depicted most often in the science fiction genre.

Of the 1298 animal species that my two classes worked on, 900 (69.3%) belong to phylum Chordata, and virtually all of these are

**Table 2. Some examples of tables constructed by students.**

| Alien's Name | Source | Phylum | Subphylum/ Class | Justification |
|---|---|---|---|---|
| (1) Hanonian Land Eel | *Star Trek* | Arthropoda | Myriapoda | "They have jointed appendages and thorax covered with thick outer shell like exoskeleton for protection. Though they appear like big worms, they have legs." |
| (2) Aganof | *Star Wars* | Echinodermata | Asteroidea | "Has tube feet used for walking; the characteristics (having no head and eyes, having radial symmetry and a lot of arms)" |
| (3) Venom Cannon | *Warhammer 20k* | Arthropoda | – | "Has visible pharyngeal slits, with cranium, jaw and paired appendages; have endoskeleton and exoskeleton; have spiracles and specialized jointed appendages; mandibulate with specialized mouthparts" |
| (4) Spawn of Cthulhu | *At the Mountains of Madness* | Mollusca | Cephalopoda | "Head looks like an octopus" |

of the subphylum Vertebrata (Craniata); 207 (15.9%) are arthropods; and 76 (5.9%) are molluscs. Interestingly, these are the three largest animal phyla in terms of number of species (Hickman et al., 2006). The remaining 8.9% of animals belong to eight other major invertebrate phyla, particularly Cnidaria (33, 2.5%) and Echinodermata (20, 1.5%), or are otherwise unclassified (9, 0.7%) because of overly confounding morphologies. A question that could be asked the students as a final synthesis point is why most species in science fiction are chordates or arthropods. That humanoid vertebrates are staples of science fiction is understandable because of our easier association with such species and the lower cost of portraying them in film or television (Csicsery-Ronay, 2007).

## ○ Assessment

After the completion of the project, the students were invited to give it ratings and qualitative feedback. A total of 20 (37%) responded to the survey through the classes' respective Facebook accounts. No inducements, such as extra credit, were given for responses, because they were made after submission of the students' final marks. Following the Likert scale, the students were asked to respond, with whole numbers ranging from 1 = strongly disagree to 5 = strongly agree, to the statements "I enjoyed the project" and "I found the project useful." The mean ratings for the statements were 3.65 and 3.80, respectively, with responses for both ranging from a low of 2 and a high of 5. The students' qualitative responses are shown in Figure 1.

In terms of meeting the learning objective, which was for the students to apply acquired knowledge of animal taxonomy, the mini-project was fairly successful; the average grade for the two classes was 88.4%, which is equivalent to a B+ in our university's grading scheme. Mistakes that lowered the percentage were due more to failure of one class to follow instructions than to errors in classification. In that class, whose average grade was 83.6% (B), many alien species that were obviously non-animal (and that the students themselves classified as various floral life-forms) were included in the analysis. Retention and understanding of lessons, as well as creative interpretation of biological principles learned, were evident from the justifications given by the students for their classifications, four examples of which are presented in Table 2.

Example 1 is a classification that involved more careful assessment of the assigned creature. The page for the Hanonian land eel shows only an image with no accompanying description. Despite the animal's name and the lack of descriptors, the student classified it as an arthropod, particularly a myriapod (the taxon of centipedes and millipedes) because of its armored and segmented appearance.

The classification for example 2 is a creative one. The entry in the Wiki describes the Aganof as having no head and yet walking on multiple legs, which are separate from larger limbs that the animal presumably uses for capture of food. Casual inspection of the accompanying image would lead one to think of it as an odd headless crustacean, but the student has chosen to interpret the multiple walking legs as akin to the tube feet with which a typical echinoderm, like a sea star, moves. The lack of a head likely proved a major diagnostic characteristic, because the echinoderms are known for this characteristic among the Bilateria.

Example 3 is a glaring example of an erroneous classification. The student's own justification points toward the more logical categorization as a chordate, most members of which also have jointed appendages. Having an exoskeleton and mandibles is not a strong enough justification for classifying an animal as an arthropod. Meanwhile, example 4 is too simplistic an approach, almost reflexively placing the Spawn of Cthulhu in the group of cephalopods merely because its "head looks like an octopus."

Grades were given accordingly, although examples like the fourth were not given significant deductions because of the large number of creatures on the Wiki that had very obvious taxonomic classifications (such as those that are very human-like).

## ○ Conclusion

Given many students' predilection for speculative fiction in literature, gaming, film, and television, creatures from these various sources can be very useful in illustrating basic concepts and principles in biology. Taxonomy, in particular, can benefit from this approach, because it allows students to assess a speculative organism's characteristics and subsequently classify it on the basis of what they had learned of the distinct characteristics of taxa. Online databases such as the Alien Species Wiki (2013) website are good playgrounds for this type of learning; the sampling of creatures from science fiction is diverse and representative of many taxa. The students determined that a large percentage of animals in the website possibly belong to phylum Chordata, subphylum Vertebrata (Craniata), which is highly indicative of the trend toward using

- "I somehow found it useful but there are some creatures in that alien thing that were hard to place in any phylum."
- "The mini project is fun because it allows the students to make a connection between cool and familiar alien species and the topics we learned from our BioLec (general zoology) class."
- "I did not enjoy it because it's too foreign to me and too unrealistic and maybe (no offense) too out of the box. I guess it was just a test of how well we knew how to classify species. And it was probably a good one. That's why I agree that it was useful because given only certain characteristics, we were tested and practiced on how to classify them. Are aliens animals or do aliens even exist and is it proper for us to classify them according to phyla under kingdom Animalia?"
- "I'm just not sure if it was useful, though I think it would be better if we're allowed to create a whole new kingdom or even a domain because all were just too weird and very strange."
- "The application of taxonomic methodologies to "alien species" that I have encountered in various video games and movies was interesting. The only problem is that some alien species listed on the link provided have no wiki pages or information attached to them on the wiki itself, so sometimes it was difficult to deal with species that one had never encountered before."
- "Although the mini-project was actually interesting, I wasn't sure how exactly the classification of alien species with allegedly alternate evolutionary paths would be useful for understanding a taxonomic system developed with the Earth's evolutionary path as a premise. Maybe if there as an encouragement to develop new taxonomic divisions for the classification of these aliens, this project may have been more useful in terms of learning."
- "It was useful. It made us apply our lessons. And I got more familiar with the phyla."
- "It was definitely a new and unique experience. I never really thought about the usefulness of this project since we're basing it on fictional characters. I mainly thought that it would just be for a fun final activity for the class and something that was kind of 'a break' from the usual serious and tedious projects."
- "The mini-project expanded my horizons in Biology. Even though it was composed of non-existent creatures, it really tested my skills in Taxonomy."
- "Division and communication between all class members was difficult and could likely be handled in a better and more efficient way."
- "Many of the aliens had a mixture of characteristics from different phyla which made the classification more difficult."

**Figure 1.** Our students' qualitative feedback on the project.

humanoid alien species across media. A follow-up study can assess which of the major vertebrate taxa (the various fish taxa, amphibians, reptiles, birds, and mammals) is most well represented among these. A cursory observation of the data provided by one class on their vertebrates seems to suggest that mammals and reptiles appear most often.

From the evaluations of the students, it could be said that the project is generally seen as enjoyable and useful, but primary deterrents to a more positive reception are the difficulties of (1) classifying animals with scientifically implausible combinations of taxon-specific characters and (2) justifying the classification of fictional species using reality- and Earth-bound concepts and principles. Additionally, several students remarked that they would have rated the project higher if more time had been given to them for its completion; the project was introduced to them some 3 weeks before the end of term.

Although the project has been generally successful in terms of meeting its learning objectives, I recommend that it be introduced immediately

before the start of the lessons on animal taxonomy and that the students be allowed to explore the possibility of creating their own taxa with the appropriate justification. The students should also be encouraged to look at the project as much as an exercise in creativity as one in biological knowledge. Impress upon them that professional biologists face much the same challenges when they discover previously unknown, bizarre organisms on Earth that seem to defy known classification schemes.

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