

Is the Two-Kingdom Classification System still being Implemented in the Classroom?

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Abstract

Although classification is important in biology (Cotterill & Foissner, 2010), very few studies have reflected on students’ conceptions of fungi (e.g., Barman et al., 2006). The present study was part of a larger project that assessed via survey and interview upper-level undergraduate biology students’ conceptions of organismal diversity. Most participants understood that fungi are not animals, but several participants thought that mushrooms are plants. Mushrooms belong in a separate kingdom from plants altogether. Therefore, students may be more inclined to use the two-kingdom system instead of a more updated classification scheme. This may be due to the use of implicit instruction using the two-kingdom system.

Purpose of Study

- Classification is essential in understanding biology, especially, ecology and evolution (Cotterill and Foissner, 2010)
- Students are expected to know classification of organisms during their secondary education (AAAS, 2009)
- Upper-level undergraduate biology-majors learn about classification again in their introductory courses
- How do these students conceptualize a basic taxonomic group?
- In other words,

What are upper-level undergraduate biology-majors’ conceptions of fungi?

History of Classification

- Historical classification scheme: 2-kingdom classification system (plants and animals) where fungi are classified as plants
- Fungi are heterotrophic which makes them more like animals than plants (Whittaker, 1957)
 - Concept led to fungi being own kingdom (in the 5-kingdom classification)
- Today: Molecular and other morphological evidence supports that fungi are more closely related to animals than plants (e.g., Baldauf & Palmer, 1993) but different enough to be in their own kingdom
 - Current classification system is three-domain system

Methods

Survey Participants (N = 59)

- Majors: Biology (n = 31), Biomedical (n = 26), and Secondary Education (n = 2) at Western Michigan University
- Class: Juniors/3rd year (n = 11) and Seniors/4th year (n = 48)
- Sex: Males (n = 30) and Females (n = 29)
- Age: Range was 20-39 years, 75% between 21 and 23 years
- Completed in upper-level biology courses that did not explicitly teach about organismal diversity: Ornithology (n = 23), Neuroethology (n = 6), Synthetic Biology (n = 12), & Great Lakes Environ. (n = 18)

Survey

- Validated by both university professors who taught organismal biology
- Showed via PowerPoint 20 photographs and 20 terms of different organisms, including a picture of and the term ‘mushroom’ (2 classes were shown the terms first, the other 2 the pictures first)
 - Asked “Is this an animal” and why (free-response) they chose their answer

Interview (N = 24)

- Semi-structured, one-on-one interviews 4 to 7 weeks after surveys
- Subsample of survey participants (14 biology majors and 10 biomed majors, 5 juniors and 19 seniors, 11 males and 13 females, average age was 22 years)
- Purpose: validate survey responses and ask about differences between plants, animals, and fungi

Data Analysis

- No significant differences between course answers (Independent-Samples Kruskal Wallis test; $\alpha = 0.05$) or demographics (chi-square test; $\alpha = 0.05$) except for major (which take same introductory courses)
- Combined all courses and performed qualitative and frequency analyses

References

AAAS (American Association for the Advancement of Science). (2009). The living environment A. The diversity of life. In: *Project 2061 benchmarks on-line*. Retrieved from <http://www.project2061.org/publications/bsl/online/index.php?chapter=5>

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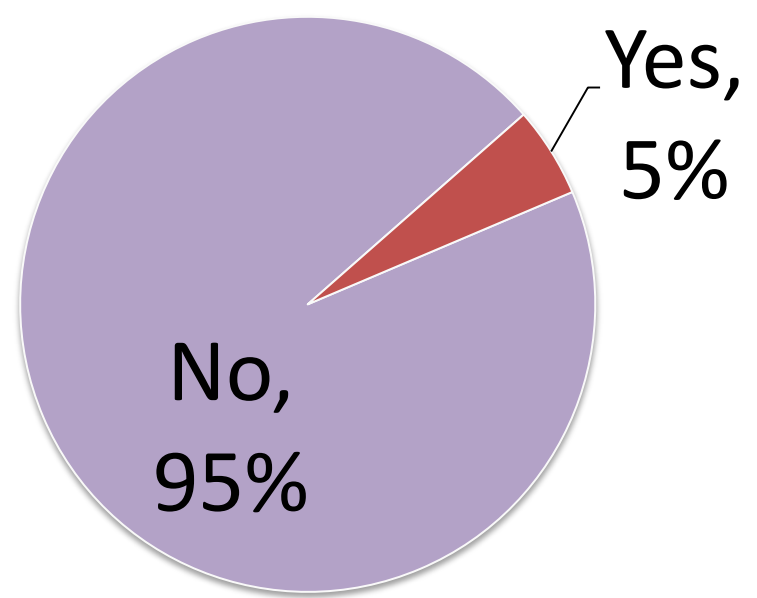
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Results

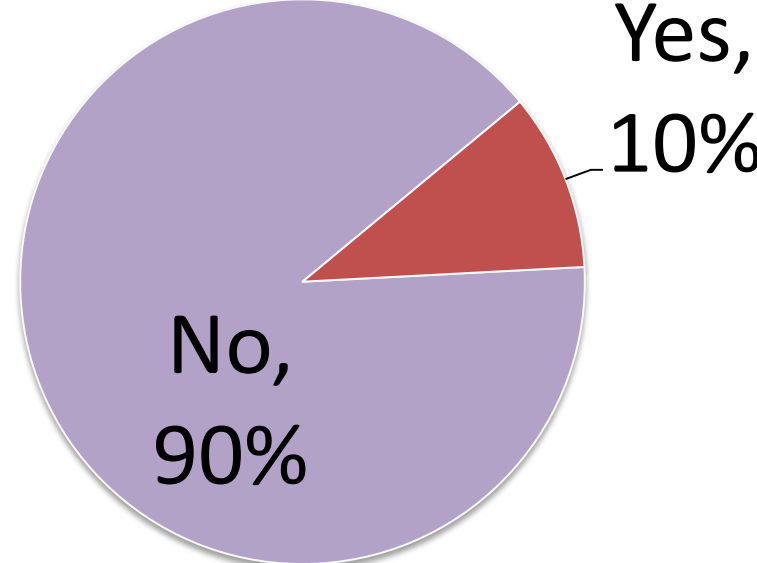


“Is this [the Mushroom] an Animal?”

Term:



Picture:



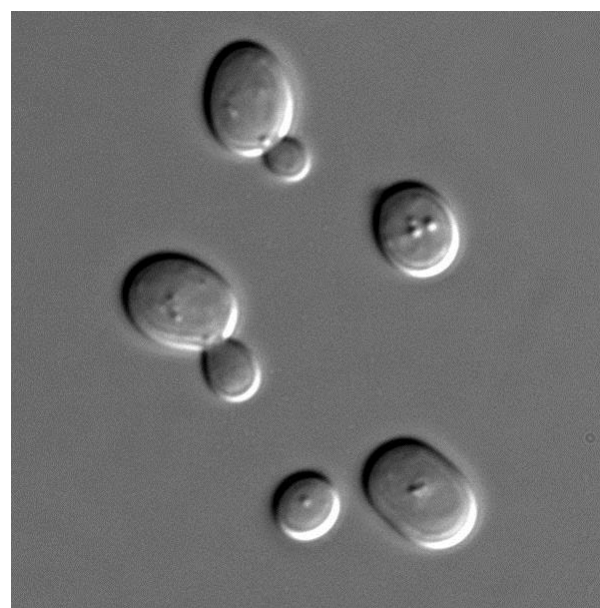
Conception	Representative Quotes	# (%) of Students
Survey Free-Response Portion for Term and/or Picture (N = 59)		
The example provided (i.e., mushroom) is a plant	<i>“Mushroom is a plant that grows in the ground”</i>	14 (24%)
Fungi, in general, are plants	<i>“Fungus is considered a plant”</i>	6 (10%)*
Fungi associated with plants	<i>“Fungi is usually associated with plants + not animals”</i>	1 (2%)
Interviewees’ Conceptions for n > 1 (N = 24)		
Autotrophic/Photosynthetic	<i>“I believe they’re autotrophic”</i>	5 (21%)
More closely related to plants but also decomposer	<i>“Fungi is more similar to plant...a lot of them are decomposers”</i>	2 (8%)
(Correct characteristics provided by 12 participants (e.g., “no nervous system”)		
*All of these participants were also included in the first conception.		

Conclusion

Although most students realized that mushrooms are not animals, nearly a quarter of survey participants conceptualized that mushrooms are plants and almost a quarter of interview participants thought fungi, in general, are photosynthetic. Since this was a free-response portion of the survey, more survey participants may have thought that mushrooms are plants but did not feel it necessary to write it. Several students simply put “fungi” in their free-response. Half of the interviewees did, on the other hand, provide scientifically accurate characteristics.

Comparisons to Other Studies

- Very little research on conceptions of fungi
 - 1970’s study on >200 English 12-year-olds: 28% of students classified the mushroom as a plant (still a fairly acceptable concept at this time; Ryman, 1974)
 - 2000’s study on national (U.S.) primary & secondary students: >50% of students classified the mushroom as a plant with little variation across age levels (Barman et al., 2006)



Implications

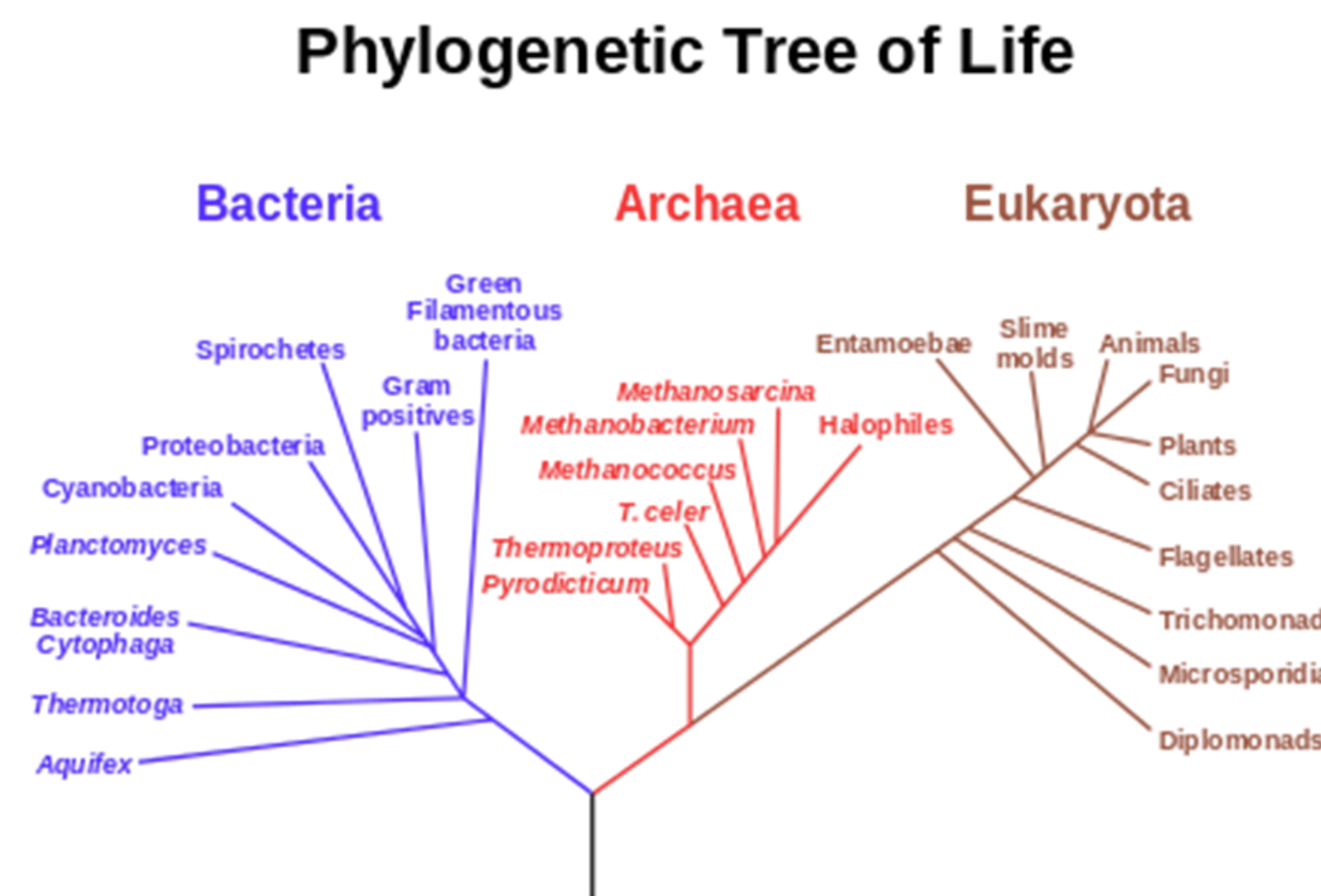
Are students using the two-kingdom classification system?

- If students were not, then students should be able to acknowledge that mushrooms are not animals because they belong in the fungi kingdom; instead many students tried to place fungi in either an animal or plant kingdom

Is the two-kingdom classification system being used in the classroom?

- Although instructors may be teaching a more updated classification scheme, may be implicitly using two-kingdom system
- Example: Project 2061 Benchmarks, 5. The Living Environment (2009)
 - “One of the most general distinctions among organisms is between **plants**, which use sunlight to make their own food, and **animals**, which consume energy-rich foods. Some kinds of organisms, many of them microscopic, cannot be neatly classified as either **plants** or **animals**. 5A/M1” (A. Diversity of Life, 8th grade)
 - “**Animals** and **plants** have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce. 5A/M2” (A. Diversity of Life, 8th grade)
 - “New varieties of cultivated **plants** and domestic **animals** have resulted from selective breeding for particular traits. 5B/M3” (B. Heredity, 8th grade)
 - “The cells in similar tissues and organs in other **animals** are similar to those in human beings but different somewhat from cells found in **plants**. 5C/M1c” (C. Cells, 8th grade)
 - “**Animals** eat **plants** or other **animals** for food and may also use **plants** (or even other **animals**) for shelter and nesting. 5D/P1” (D. Interdependence of Life, 2nd grade)
 - “At the base of any food web are organisms that make their own food, followed by the **animals** that eat them, then the **animals** that eat those **animals**, and so forth. 5D/M4” (D. Interdependence of Life, 8th grade)
 - “**Plants** and **animals** both need to take in water, and **animals** need to take in food. In addition, plants need light. 5E/P1” (E. Flow of Matter, 2nd grade)
 - “Different **plants** and **animals** have external features that help them thrive in different kinds of places. 5F/P1” (F. Evolution of Life, 2nd grade)
- Otherwise, refer to “**organisms**”; no use of other classification terms (e.g., fungus)

Teaching Implications: Need to use explicit AND implicit instruction of a current classification scheme in the classroom



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