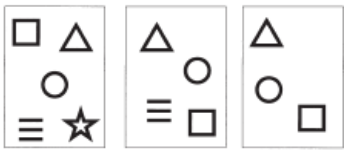
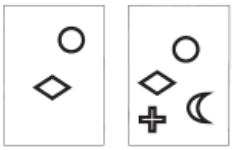
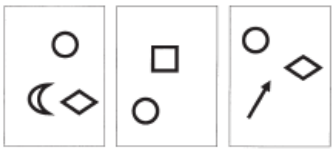
Teaching Oceanography Workshop 2013
Tree-thinking Activity

The following instructions for the *Great Clade Race* are adapted from Goldsmith (2003). Each group of 2-4 students is given one set of 8 cards with the following symbols:







Symbols:

1. Circle = Wheel
2. Square = Pirate flag
3. Triangle = Ship
4. 3 Lines = Waves
5. Star = Starfish
6. Diamond = Shell
7. Moon = Octopus
8. Cross = Anchor
9. Arrow = Cutlass

Cards:

1. Square, triangle, circle, 3 lines, star
2. Triangle, circle, 3 lines, square
3. Triangle, circle, square
4. Circle, diamond
5. Circle, diamond, cross, moon
6. Circle, diamond, moon
7. Circle, diamond, arrow

Introduction: These cards represent cards carried by eight runners in an imaginary race through the woods.

- The racecourse is made of diverging paths.
- As runners encounter a fork in the path, they choose to go to the right or left, and continue in this manner to the finish line.
- Although every runner starts the race at the same place, each runner finishes the race at a separate finish line.
- Along the legs between the forks in the path are check-in stations.
- Each check-in station has a unique stamp.
- As runners pass a station, they stop to collect a stamp.
- Students must draw a map of the racecourse that shows:
    - forks in the road,
    - check-in stations (with stamps), and
    - finish line for each runner.

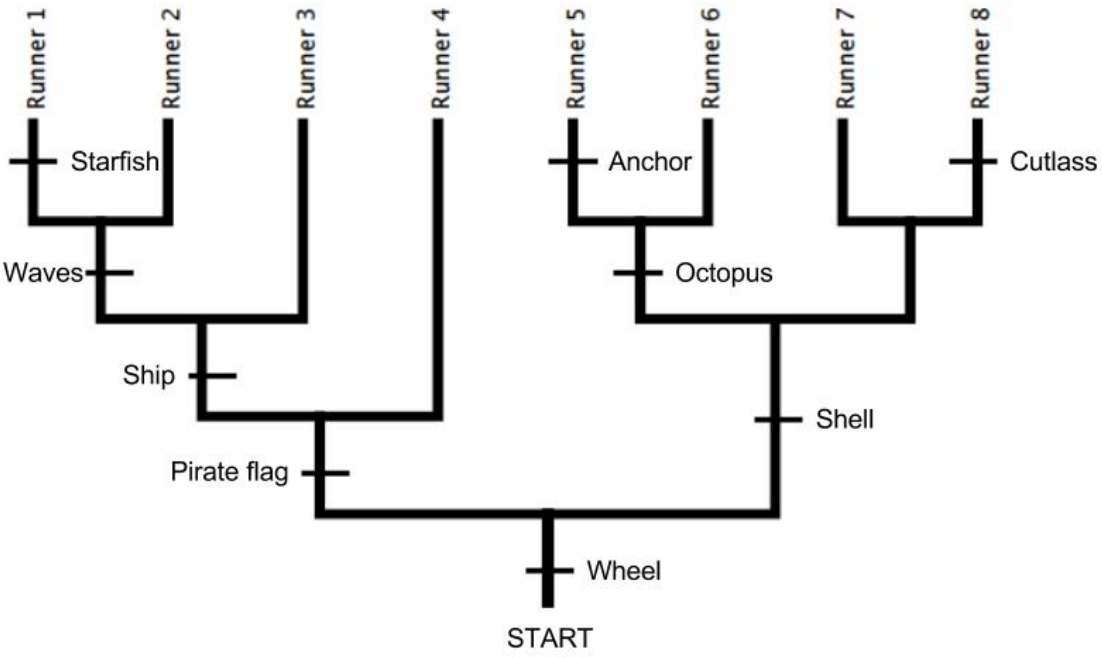
Rules:

1. All runners must complete the race (they cannot drop out of the race).
2. When the path branches, it only branches into two new paths, never three or more.
3. Once the paths have branched they can never reconnect.
4. Check-in stations are located along the legs between the forks in the path.

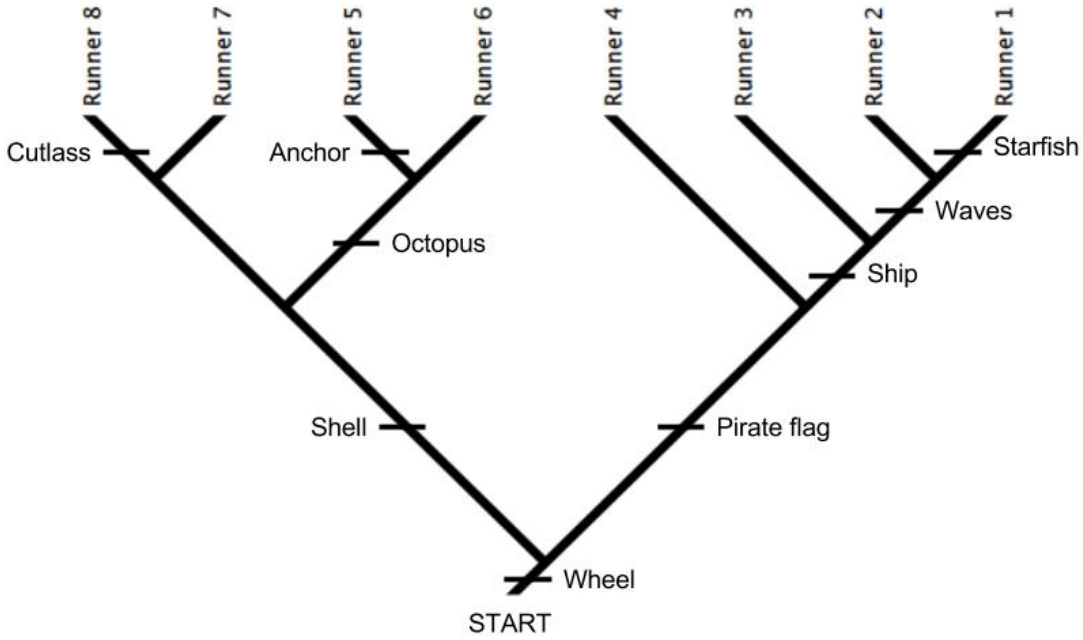
Notes:

- There are several correct racecourse paths or trees.
- The pattern of branching, or topology, is what is important.
- Branches can be rotated around the nodes (forks in path).
- The shape of the tree may differ: square, curved, diagonal, etc.
- The length of each leg is irrelevant in this activity.

Examples of correct diagrams or trees:



Clade Race Tree 1



Clade Race Tree 2

Analogies between cladogram & racecourse:

- Paths = evolutionary lineages
- Root of tree = start of race
- Nodes = forks in path
- Branches = legs of racecourse between forks in path
- Taxa = Runners
- Diagnostic traits plotted on tree = stamps collected by runners
- MRCA = group of runners just before they choose to go down different paths at a fork
- Clade = the entire group of runners on this course—they all start in the same place (common ancestor), although they end up at different finish lines (all of descendants)

Other ideas:

- Goldsmith (2003) suggests adding a ninth card for a second activity that demonstrates the concept of homoplasy.
- Use stamps, instead of drawing the symbols by hand.
- Have the students reconstruct a data matrix showing the distribution of traits (stamps).
- Have the students complete either of the "Tree-thinking Quizzes" that are included as a supplement to Baum et al. (2005).
- Other resources on tree-thinking include: Baum (2008), Baum and Offner (2008), Baum and Smith (2013), Smith and Cheruvelil (2009), Meisel (2010).

References Cited

Baum, D. A. 2008. Reading a phylogenetic tree: the meaning of monophyletic groups. Nature Education. http://www.nature.com/scitable/topicpage/reading-a-phylogenetic-tree-the-meaning-of-41956.

Baum, D. A., and S. Offner. 2008. Phylogenics & tree-thinking. The American Biology Teacher 70(4):222-229.

Baum, D. A., and S. D. Smith. 2013. Tree-thinking: An Introduction to Phylogenetic Biology. Roberts and Company Publishers, Greenwood Village, CO.

Baum, D. A., S. D. Smith, and S. S. S. Donovan. 2005. The tree-thinking challenge. Science 310(5750):979-980.

Goldsmith, D. W. 2003. The Great Clade Race: Presenting cladistic thinking to biology majors & general science students. The American Biology Teacher 65(9):679-682.

Meisel, R. P. 2010. Teaching tree-thinking to undergraduate students. Evolution: Education and Outreach 3(4):621-628.

Smith, J. J., and K. S. Cheruvelil. 2009. Using inquiry and tree-thinking to "March through the animal phyla": teacing introductory comparative biology in an evolutionary context. Evolution: Education and Outreach 2(2):429-444.