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The Masquerade Game: The Natural History of Marine Mimicry Adaptation Between Egg-cowries and Octocorals

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INTRODUCTION

The Masquerade Game is a board game created by Sánchez, Fuentes-Pardo, Amhain, Ardila-Espitia, Cantera-Kintz, and Forero-Shelton (2016) and named for the mimicry adaptation of egg-cowries (marine snails) to coral hosts. It demonstrates principles of evolution and ecology based on the research of Sánchez et al. (2016), from observations of the eggcowries and Pacifigorgia spp. (sea fans) at Malpelo Island off the coast of Colombia in the Pacific Ocean. In order to reflect the natural processes in this ecological niche, event and *impact* cards were developed taking into consideration the probabilities of occurrence that were observed (Sánchez et al. 2016). Impact cards add information on natural and catastrophic events thereby defining the life or death of the 'coral game pieces.' Event cards describe phenomena related to the life cycle of egg-cowries and sea fans. This game simulates biologically relevant processes exposing the players to concepts in ecology and evolution while the game is being played. This game has been implemented with select classes in Bogotá, Colombia with positive feedback from students, as it made abstract concepts more concrete. We used the game in a marine ecology class as a demonstrative tool for an assignment, which included the development of a similar tool in any format. The students found that this was an interesting way to communicate to K-12 students or general audiences about life in the ocean and the constant pressures of selection.

The original research explored the biological factors leading to camouflage behavior of egg-cowrie snails on their hosts, octocoral sea fans. This case study shows an excellent example of natural selection with predation and reproductive aggregations contributing to the differences in phenotypic expression of colors for the egg-cowries. It also shows the impacts invasive species and disease can have on populations of egg-cowries. Specifically, the findings from this research showed that the mimicry behavior of egg-cowries to their hosts, was not necessarily attributed to speciation, as is often thought. Through genetic analysis it was found that egg-cowries from different hosts and with different colorations had little differences in the sequencing of the two mitochondrial genes studied, indicating the importance of phenotypic plasticity.

This lesson is designed for an inductive teaching approach, where we use specific examples in a case study to help students construct the definitions by generalizing the examples (Chiappetta and Koballa 2010). The Masquerade Game could be played at the beginning of the unit and generalizations would be made using the specific case study example. Inductive approaches are favorable in that they allow students to construct the knowledge, instead of being provided definitions and descriptions from the instructor. However, inductive approaches may take more time and may not work for all audiences (Chiappeta and Koballa 2010).

This lesson could also be framed through a deductive teaching approach, where general definitions are provided and then students explore further with a lab or activity as a specific example. To use a deductive approach, the simulation game can be played at the end of a unit on population dynamics after teaching topics such as natural selection, adaptation, predator-prey relationships, interactions between native and invasive species, the effects of disease, and reproduction and recruitment processes. Students then apply the natural selection and ecological concepts learned in other lessons to this activity. If using a deductive approach, the teacher may decide to omit the completion of the "Synthesis of Background Information for Students" to reduce instructional time. Additionally, this simulation game could be used as a form of summative assessment at the end of the unit. Students could also prepare a presentation or analysis paper that explains the topics taught in the unit in general terms to how they are applied in the simulation game using specific examples to justify their reasoning.

ENGAGE

Before playing the Masquerade Game, it is recommended that students have an opportunity to review videos of the Malpelo Islands as background. Several options of potential Volume 33 • No. 2 • Summer 2019

videos are included at the end of this article in Resources on page 47. By showing a video, students are able to better visualize and get a sense of place prior to playing the game. If students are more advanced, the teacher may opt to have students read the original scientific article in which the Masquerade Game was created (https://peerj.com/ articles/2051/#supp-1).

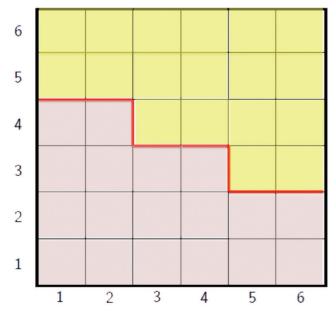
After watching the video, students will then read the background information about the game and answer questions that will help them understand the moves of the game and how they connect with the science. All game Resources can be accessed online at https://static1.squarespace.com/ static/5b4cecfde2ccd188cfed8026/t/5d5a25006b4199 00019c6863/1566188863065/The-Masquerade-Game-Resources.pdf. Students may need to use the internet to research terms or refer to their textbooks or other resources. Teachers should decide in advance what sources will be used and how will they provide access to the students. The Synthesis of Background Information and Research for Students (Resource 1 accessed at link above) requires that students make connections between the specific case study and the general ecological concepts. It also allows students to think about the different interactions in the games and the moves for each interaction. Teachers may opt to have students work in groups or assign this portion for homework. After students work on the background information sheets individually, they should be given the opportunity to review and revise their answers with other students.

ACTIVITY

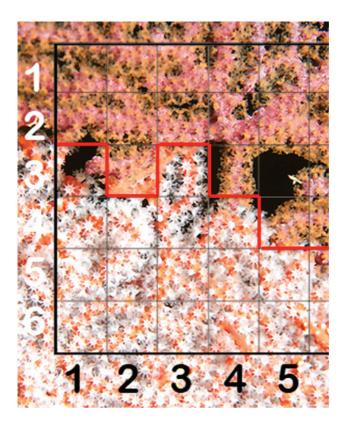
In the masquerade game, two teams of cowries (a porcelain sea snail) compete over generations to be the first to colonize the coral patch where they can masquerade from predators.

Materials

- 30-50 "cowries" per team: any object can be used for cowries such as different colored beans or beads
- One board: sketched on paper or printed from the supplementary materials. The playing board is 6 by 6 squares, divided in half, one side for each of the two teams, and each side can have a specific color that matches that of the cowries. The division is not necessarily a straight vertical line down the middle and each half has different colored squares (see sample images to right). Each row and column have a number 1-6 assigned to it. This creates a coordinate system, so that all squares can be identified by the roll of 2 dice.



Sample game boards (here and below). Courtesy of Juan Sánchez



- Two dice: each with 6 sides and ideally of different colors. The first die rolled represents the row and the second die the column. If they have different colors, one can represent rows, the other columns.
- One predator: represented by a bean of another color, a bead, a playing piece from another board game, or some other small item.
- One super predator: can be represented by a playing piece different from the above.
- Event and impact cards: These can be printed (see online access link to Resource 6 on page 44) and are placed upside down next to the board after mixing, in one pile. Alternatively, a standard 52-card deck can be used, in conjunction with their equivalent actions and impacts, following the equivalence table in the supplementary materials (see online access link to Resources on page 44).

Rules of the Game

- There are two teams of 1-3 players. Each team initially chooses where to place 6 of their cowries on the board.
- The players should place the *predator* in the center of the board. The *super predator* will be kept off the playing board at the start of the game.
- Using a die, players will decide which team will have half of the board and color-matched cowries.
- The objective of the game is for the players to colonize their patch of coral by having at least one cowry in each of the squares in their half of the board.
- At each turn, the team moves one of their cowries, draws a card, and follows the directions on the card. There can be no more than 6 cowries in a particular square at a time, due to overcrowding. These cards can do several things such as allowing an extra move for the team, and provide events at positions designated using the dice.

Teacher's Notes

It is very probable that students may have placed more cowries in the other team's half of the board versus their own.

Resources 1 and 2 (see online access link on page 44) provide information for the descriptions of the types of play and the code for what the cards in a regular playing deck represent.

Remind students that when they roll the dice, the first one rolled will represent the row and the second one rolled will represent the column (see Resources online for directions describing the different types of moves).

Students will continue to play until only one color of cowries remains, or one side of the board is matched with its coordinating cowries. As students play the game, they are encouraged to write down observations that relate to the movement of cowries, the addition and removal of cowries, the impacts of the different events, and any other trends (see online access link to Resource 7 on page 44 for an optional observation document that students can use).

Explain and Elaborate

After students complete their game, the teacher will want to debrief by having students share the observations they made during play. The teacher may need to provide question prompts to encourage the discussion. These may include any questions specific to the different types of play or general questions about how the number or location of cowries changed. Teachers may also want to ask questions about what kind of strategies helped one team to have an advantage and win, and what kind of plays contributed to the other team losing.



Sample game boards used during the game by students. Courtesy of Juan Sánchez

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Egg-cowries using camouflage in their marine environment. Courtesy of Juan Sánchez

Following the class discussion, the teacher provides the game analysis worksheet (see page 48) for students to complete. Students are encouraged to look at their answers in the background information synthesis worksheets (see online access link to Resource 2 on page 44), their observations from the game, ideas from the class discussion, and other resources provided by the teacher to complete the worksheet. The teacher can assign the game analysis worksheet for homework or classwork and can also decide if they will be completed in teams or individually.

Evaluate

After the game analysis worksheet is complete and the answers have been discussed or reviewed by the teacher, students will then complete the Simulation Game Debrief worksheet (see online access link to Resource 5 on page 44). Again, the teacher has options for how to implement the completion of these questions. These can be guidance questions for a class or small group discussion. The teacher could use a Think-Pair-Share strategy or a Turn and Talk for each of the questions. Or the teacher could require these to be completed by the students either individually or in teams.

CONCLUSION

This lesson, based on a simulation game and the research of Sanchez et al. (2016), helps students to learn about different ecological interactions and determine the impacts they have on the population and distribution of the organisms. The game has been tested on a small number of classes in Bogotá. It allows students to experience a real-life example through a hands-on simulated game. Additionally, this lesson is different from other activities or games on similar topics, as it includes many of the key processes that are affecting the population numbers and distribution of the egg-cowries—and is not an over-simplified model focusing on only predator and camouflage of the prey within their environment. Thus, it provides a more realistic model for natural selection, taking into account predation, reproduction and recruitment, and invasive species and disease.

Content area: Oceanography or Biology course

Grade level: 9-12

Big idea/unit: Evolution, Natural Selection, Ecological Interactions

Essential pre-existing knowledge:

Time required: Two 45-minute class periods with possible homework assignments

Cost: \$0-\$30 (depending on what supplies you already have, each group of 4 students will need a deck of playing cards and some objects to be used as playing pieces, as well as a game board that can be created)

Safety: No extra precautions needed

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RESOURCES

All 'Resources' noted in the activity for teaching this lesson can be accessed online at https://static1.squarespace.com/ static/5b4cecfde2ccd188cfed8026/t/5d5a25006b4199 00019c6863/1566188863065/The-Masquerade-Game-Resources.pdf

- Background Information for Students: Highly Probable and Less Probable handout
- Synthesis of Background Information and Research for Students worksheet
- Key for Cards handout (if using a regular card deck)
- Student Observation sheet to be used during play
- Simulation Board Game Analysis worksheet (see page 48 and additional questions online)
- Simulation Board Game Debrief worksheet
- Playing Cards

Videos

- National Geographic video about Malpelo Island: https:// www.youtube.com/watch?v=RW1KfLWKIa8
- Overview of organisms on Malpelo Island: https://www. youtube.com/watch?v=34R7RvsuTyc
- Describes sharks and their habitat on Malpelo Island: https://www.youtube.com/watch?v=IL9uk8WAG0I
- Overview of Malpelo Island and conservation focus: https://www.youtube.com/watch?v=PUhxjjHVYFE

REFERENCES

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Egg-cowries are used to learn about real-life organisms in this hands-on game. Courtesy of Juan Sánchez

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SIMULATION BOARD GAME ANALYSIS SHEET

Compare and contrast the different characteristics of the simulation game as they relate to the science research. Justify answers using specific examples from the actual science research for the various characteristics of the game. Use the Simulation Game Rules and the Background Information for Students as resources from the link provided in this activity to complete the table below.

Characteristics of the Game	Similar to Science Research	Different from Science Research
Distribution of octocorals		
Camouflage of prey with octocorals		
Method of movement for typical predators		
Method of movement for super predators		
Process of predation by typical predators		
Process of predation by super predators		
Process of Reproduction		
Process of Recruitment		
Movement and process of disease due to fungi		
Movement and interaction of invasive species with natives		