The Nucleus

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From the Editor:

A hot topic among science educators for many years has been the "theory" of evolution. Just the word causes some students to become defensive, bracing themselves for an attack on their faith and family. Charles Darwin himself delayed releasing *Origin of Species* fearing the backlash from religious and cultural institutions.

Perhaps it is easier to avoid potential confrontation by simply omitting the word from our curriculum. (The Kansas State Board of Education tried and became a national laughing-stock.) But, the decision of whether to teach evolution is not for teachers to make.

In Texas, state laws mandate learning objectives. The Biology TEKS number seven specifically states "the student **knows** the theory of biological evolution" and is expected to "identify evidence of change...and illustrate the results of natural selection in speciation, diversity, phylogeny, adaptation, behavior, and extinction."

What we teach is non-negotiable. The fun comes deciding how to teach it. Our challenge is to provide activities which allow students to comfortably integrate new ideas into their experiential world. This issue of *The Nucleus* is dedicated to ideas and lessons to assist in that endeavor.

As new teachers join our profession, it is vital that experienced coworkers act as mentors, providing encouragement and techniques for covering *all* elements of our curriculum. An impossible task if we, ourselves, aren't knowledgeable and confident.

Controversial topics are an opportunity for discussion. Misconceptions are abundant and classrooms provide better and more accurate information than many media sources. Evolution is not just "man from monkey". The mechanisms involved are complex but irrefutable.

Just as America is made stronger by its diversity, so is nature. As one organism among many in a complex web of interrelatedness, humans have an obligation to be insightful guardians of our planet. Understanding evolution is a necessary element in that stewardship.

In the spirit of community, I would like to share a little song I use to introduce my students to evolution. It was written by a group of "woodies" and is sung to the tune of "Frere Jacques".

Evolution, Evolution
That means change, That means change
Everybody does it, Everybody does it
Or you DIE ... or you DIE.

Inside this issue:

The Birth of Science and Reason: Investigating the Magic Hooey Stick

The following activity was shared by John Banister-Marx and can be used with learners as young as fifth grade. Students should "learn the scientific method and its value in developing, infering, and refining naturalistic mechanisms to explain patterns in nature." Teachers can build up to the lesson by showing the NOVA video *Secrets of the Psychics* and introducing an "official letter" such as the one below:

Dear Valued Customer:

Thank you for your request for sets of our Magic Hooey Stick. We think that you will agree that they are the finest quality and possess the most active Hooey spirits that money can buy. To activate any of your Hooey Sticks begin by changing the following mantra:

Itzabeem locotada munzuneetee kolaseetseim

Once you have changed the magic mantra several times, you are ready to begin. Merely rub the serrated stick with the thin stick and the small propeller will turn. You can then test your psychic abilities by saying the word "Hooey". If you are concentrating fully, you will be able to change the direction of the propeller. People with expecially strong psychic abilities have even been reported to be able to communicate telepathically to get the Magic Hooey Stick propeller to reverse direction.

Should you have an interest in checking the scientific periodical literature regarding the proven nature of the Magic Hooey Stick, we recommend that you obtain a copy of either of the following:

Bosonich, Ima. "Quantitative Experimental Analysis of the Psychic Nature of Rotation in a Magic Hooey Stick." Journal of Scientific Inquiry. vol. 712. March, 1994, pg. 39-44.

Trictya, Shoulda. "Enzyme Analysis of Spirit Entities Regulating Reciprocating Rotational Inertia of a Magic Hooey Stick." True Science Magazine. November, 1995.

After this dramatic introduction, students are ready to use their sticks. These may be ordered from John by contacting him at aejbmarx@sedona.net or teachers may construct them as follows:

1. Cut a 3/8" dowel into six 6" lengths.
2. Cut 1/4" dowels into six 4-1/2" lengths, six 1-3/8" lengths.
3. Sand the ends and edges to prevent splintering.
4. Use a 1/16" drill bit to put a hole in the center of one end of the larger 3/8" dowell to a depth of 5/8".
5. With a pencil, mark 1" from the end of the dowel with the drilled hole. From this mark, please 10 more pencil marks exactly 1/4" from each other for a total of 11 pencil marks running approximately half the length of the dowel.
6. Using a 1/8" drill bit, drill a perpendicular hole all the way through at the exact middle of the small 1-3/8" long 1/4" dowel.
7. Check for drill hole splinters on this small piece and sand smooth around hole.
8. Sand polish the ends of this small 1-3/8" piece.
9. Place the larger 3/8" dowel piece in a vice and create the 11 grooves using a bastard half round file. This will take approximately 6-8 strokes to create each 1/8" deep groove. Best to have the groove somewhat "V-shaped".
10. Tap a 1-1/4" (3d) nail through the propeller to the main (notched) shaft to hold the propeller in place.

Rubbing the smaller stick along the notches starts the propeller spinning. Changing the location of your finger causes it to change direction. Experiment! And contact John for any questions or comments.

The Lost Diversity of Easter Island

Around 350 AD, voyagers from the Marqueasas Islands landed on the small island now known as Easter Island. This small island, a 64-square mile eastern outpost of Polynesia, was a lush paradise containing dense palm tree forests, toromino and other shurbs, hauhau plants, and many kinds of grasses. The arriving voyagers cut down the palm trees whenever they needed to build their long canoes to fish for food and cut down the hauhau plants to make ropes from their fibers. The toromino shrubs were used for their fuel source. The native palm forest and grass lands were also cut down in order to farm the banana, sugar cane, taro, and sweet potato plants they had brought with them and that supplemented their fish and dolphin diet.

By 1400, almost 15,000 people lived on the island. They had a structured society that saw to the allocation of the island's resources. But intensive farming had depleted the farmland, native birds had been hunted to near extinction, and the palm trees had almost all been cut down to build ever bigger canoes to fish at farther and farther distances. In desperation, the islanders began appealing more dramatically to their gods and erected numerous large stone statues around the island.

In 1550, war broke out over the dwindling food supply and space on the hisland. By this time, the hauhau had become extinct, having been used up to cook the islands rats that were farmed in the struggle for survival. With the palms gone and the fishing waters depleted, the islanders began to consume the only remaining source of protein on the island--one another.

The once highly structured society crumbled as warring gangs took over. The remaining grasslands were burned to destroy any hideouts. The winners ate the losers. By 1722, only 100 or so islanders remained, living in the caves of this now barren island stripped of its trees and maintaining only a few grasses and a few shrubs. In 1774 when Captain James Cook visited the island there were only four canoes that leaked badly and had to be continuously bailed in order to remain afloat. Many of their stone statues had been tipped over or destroyed.

1. In what ways were the native plants on the island used by the arriving voyagers?

2. How did the non-native plants compete with the native plants on the island?

3. Describe the difference between the number of different kinds of plants in 350 and 1722 AD. This difference is called a loss of biodiversity.

4. How did the loss of biodiversity have an impact on the island dwellers?

5. How might the loss of biodiversity have been changed?

This lesson was developed by Debbie Richards of Bryan High School. She recommends following it with a lab where students sort beans (from 10 bean soup mix with a little corn thrown in to provide monocot representation). They begin the lab by estimating th etotal number of seeds and the total number of species they represent. After the seeds are sorted and counted, students select the two species which appear the most different, designating them Seeds A and Seeds B. The remaining seeds are arranged in order of similarity between A and B. Post lab discussion involves the ease or difficulty of identifying species, and the criteria used to sort them.

What a Beak

Students determine how variations in bird beaks could lead to speciation.

Background Information:

Some scientists think that organisms within the same species can undergo enough changes over time to prevent interbreeding between some populations. This leads to the formation of another distinct species and is called **speciation**. This may occur when a group of one species of organisms becomes isolated from their own population. As natural selection chooses the fittest individuals to survive and reproduce, their traits are passed on to their offspring. Scientists think this slow process of change causes distinct differences in these isolated organisms compared to the original population from which they came.

Charles Darwin made observations (while on his research adventure around the world during the 1830s) that led many biologists t o theorize about speciation. Darwin drew sketches and collected many specimens of birds while visiting the Galapagos Islands near South America. He noticed that these birds had similar characteristics to birds on the mainland, but their beak shapes and sizes were very different.

Upon his return to England, zoologists informed him that the birds he thought were wrens, warblers, and blackbirds, were actually all finches. The differences in the beaks began Darwin thinking about how a bird's beak may allow it to eat different types of food more efficiently. If a mutation allowed a bird to become more fit by obtaining more food, then it would pass on these characteristics to its offspring. Eventually over time, these changes would be passed down for generations and these "new" birds would no longer interbreed with the "original" birds - thus you would have a different species.

Darwin made observations of birds, their beaks, and their food sources. He noticed that the size and shape of a bird's beak was specifically designed to eat specific types of food. Looking at a bird's beak can help you determine the types of foods different birds eat. Short, thick beaks are good for cracking and opening seeds. Narrow, pointed beaks help birds dig insects out of small cracks. Powerful, hooked beaks are suited for tearing or gripping prey such as mice. Long, spear-like or wide beaks help some birds catch fish. Broad, flat beaks are good for straining mud and water for food.

In this investigation, you will determine how the differences in the size and shapes of beaks allow birds to take advantage of a variety of food sources. Being able to utilize a food source and survive allows a bird to pass on its characteristics to its offspring.

Materials

Timer, scissors, chopsticks, spoons, clothespins, felt squares, spaghetti noodle-worms, raisin-grubs, marble-snails

Procedure

Safety Note: Use scissors and chopsticks in an appropriate manner.

1. Spread the felt square on a flat surface. Each student selects a utensil to us as a "beak".

2. Sprinkle the spaghetti-noodle-worms across the felt square.

3. When the teacher calls time, all students should use their "beak" to feed for 30 seconds. Food can be picked up with the beak only one piece at a time.

4. Construct a data table to record the number of pieces of food eaten by each beak.

5. Repeat steps 1-3 for the raisin-grubs and then for the marble-snails, and add the results of numbers eaten to the data table.

Phasing Labs

In recent TexTeams training, Lisa Duvall of RonJon Publishing shared techniques for weaning students from Phase 1 or "cookbook labs" which provide precise written directions. These labs allow students to become familiar with procedures and begin data interpretation. Once students are proficient, they move on to Phase 2.

In Phase 2, some parts of the lab handout are removed (usually a data table or graph). Practice here allows students to "easily identify the manipulated and responding variables and label appropriate axes on a graph.

Phase 3 labs provide students with "real world scenarios and an outline of the scientific method". They must use the steps in the scientific method to design and complete their own lab.

Phase 4 labs are most challenging and "require students to perform at the level the National Science Standards. Students work through real world problems using their own criteria and design their data presentation for a specific audience such as supervisors or local officials and may include journal entries and working models.

An example of a modified lab follows.

She's Bugging Me

With the new craze for organic gardening, you have been working on a breeding program involving ladybugs. You have been able to breed a larger variety of ladybugs that are capable of feeding on a variety of plant-eating pests in addition to aphids. You know this new and improved ladybug will appeal to a large number of gardeners! However, your breeding program has resulted in ladybugs with unusual genetic variations. While breeding for the larger size, your ladybugs lost their bright orange coloration and their noxious odor; now they are green and do not produce a protective stench!

You are familiar with adaptations and camouflage in insects and believe this green color will be a favorable change for the large ladybugs. Your financial backer, Mrs. Ima Rich, is insisting no one will buy green ladybugs! You try to explain to Mrs. Rich that if the bugs were bright orange they would become easy prey. Design an investigation that will prove to Mrs. Rich that the new green coloration is a positive change and is necessary to help the bugs survive and reproduce. You will also share this information with your customers.

Plan your procedure, step-by-step, so you can show Mrs. Rich exactly how you conducted your test. Remember, she is not science savvy, so you must give her some background information about natural selection. Present the data in a graph and explain how ladybug populations may be affected by predator-prey interactions, resource shortages, and changes in the environment. Choose from the materials below to conduct your investigation.

Materials:

50 cm length of fabric containing various shades of green; plastic bag containing 20 dots each of green, orange, and yellow construction paper; plastic bag containing 40 dots each of green, orange, and yellow construction paper; green, orange, and yellow colored pencils; paper

After completing the investigation and your write-up for Mrs. Rich, design the label that will be placed on the ladybug boxes to explain how the new green color of the ladybugs will be beneficial for the bugs.

What a Beak continued:

6. Construct a bar graph of the data in your table.

Discussion Questions

1. Whath is a species?
2. Define speciation.
3. What type of beak would a bird have if its main source of food were snails?
4. Predict how a mutation in beak size and shape could lead to speciation in a group of birds that become isolated from the original population.
5. How can variation in bird beaks lead to speciation?

The Best Bess Beetles

Students analyze variation and behavior in Bess beetles.

Background

The short-horned stag beetle, *Passalus cornutus,* commonly called the Bess beetle, is found in the eastern United States and south Texas deciduous forests. These large, shiny, black beetles exhibit complete metamorphosis. The adults live in pairs, with both sexes sharing the tunneling and family care duties. Eggs are laid in tunnels in decomposing wood. The larvae are fed finely chewed wood chips mixed with feces by the adults. The larvae require several months for development and often generations will overlap. The adult stage can last from 6 to 12 months.

Materials

Balance, Bess beetle in a cup, Petri dish, ruler, pennies, twine, paper towel, tape, and hand lens

Procedures

ANIMAL SAFETY: Bess beetles are living organisms and must be handled with care and respect.

SAFETY: Keep your fingers away from the beetles' pinchers. Wash your hands after handling the beetles.

1. **Measure the mass of an empty petri dish to the nearest tenth of a gram. Record the information in Table 1. Pick up the beetle by gently holding it on either side of its abdomen with your thumb and forefinger and place it on its back in the petri dish. Measure the mass of the dish and the beetle to the nearest tenth of a gram. Record the information in Table 1.**

2. **Calculate the mass of your beetle by subtracting the mass of the dish from the mass of the beetle and the dish, and record your calculation in the Table 1.**

Table 1

	Measurement
Mass of empty Petri dish	
Mass of beetle and Petri dish	
Mass of beetle	
Average mass of class beetles	
Difference between average mass of class beetles and group beetle	

3. **Keep the beetle on its back and measure its length from tip to tip to the nearest tenth of a centimeter. Return the beetle to the cup. Record the information in Table 2.**
4. **Weigh a penny to the nearest tenth of a gram, and record your measurement in Table 2.**

Table 2

	Measurement
Length of group beetle	
Average length of class beetles	
Difference between average length of class beetles and group beetle	
Mass of one penny	
Average mass of class pennies	
Difference between average mass of class pennies and group penny	

5. **Describe how your beetle varies in mass and length from the average beetle.**

6. **How much mass do you think your beetle could pull?**

7. **Using the materials provided, determine the mass that can be pulled by your Bess beetle. Tape the paper towel to a flat surface. Use the twine to shape a lasso and slip it over the head and body of your beetle until it fits snugly, but not tightly, around the middle of the body between the thorax and abdomen. Tape the other end of the twine to the petri dish.**

8. **Place your beetle on an edge of the paper towel so that the beetle can grip the towel as it walks across the towel. The Petri dish should be on a flat and smooth surface.**

9. **When the beetle begins to walk and pull the Petri dish, add one penny at a time to the dish until the beetle can no longer move. It may be necessary to reposition the beetle to prevent the dish from touching the paper. Do not prod or push your beetle.**

10. **Once the beetle has reached the maximum weight it can pull, gently remove the twine from the beetle and place the beetle in the cup.**

Bess Beetles continued

11. Count and measure the mass of the total number of pennies the beetle was able to pull. Record this information in Table 3.

Table 3

	Measurement
Number of pennies beetle pulled	
Class average, number of pennies	
Difference between the class average number of total pennies pulled and number pulled by group beetle	
Total mass pulled by group beetle	
Class average total mass pulled	
Difference between the class average mass of total pennies pulled and mass of pennies pulled by group beetle	

12.Describe how your beetle varied in the number and mass of total pennies pulled from the average beetle.

13. How did your actual results compare with your predicted results given in step 6?

14. As a class construct a scatter plot graph of the class results for length of beetle and mass pulled.

Construct another scatter plot graph of the class results for mass of beetle and mass pulled.

15. What do the graphs indicate? Is there any connection between the amount of mass pulled and the length or mass of the beetle pulling?

16. Observe the beetle's appendages with a hands lens. What anatomical adaptation does the beetle have that allows it to exhibit the pulling behavior?

17. Which of the class beetles would most probably survive and reproduce in its normal environment?

Texas Teachers Attend Humankind Emerging III

by Loretta Loykasek

From left, Loretta, Staci, and Ginger determine the evolution of hominid skulls...with John's help.

On June 26-30, 2002, three Texas teachers--Loretta Loykasek, Staci Saner and Ginger Torregrossa attended the HE III summer workshop titled "From Big Bang to Bioethics, Comprehending our Evolutionary History and Technological Destiny" it is sponsored by the Wright Center for Innovative Science Education at Tufts University in Camp Verde, Arizona. Participants received 20 staff development hours.

John Banister-Marx conducted the workshop. He introduced teacher participants to the topics of evolution and the nature of science using a variety of laboratory activities, video and literature reviews as well as field trips to the Museum of North Arizona and Red Rock State Park. Examples of activities ranged from the Magic Hooey Stick to a Calculating Cousins activity. Did you know that cockroaches are modern day humans 700,000,000th cousin 700,000,000 times removed?

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Texas Association of Biology Teachers

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