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Using Herps (snakes, lizards, frogs) to Demonstrate Genetic Principals in the Classroom

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Eileen Underwood received her PhD in Developmental, Cell, and Molecular Biology in 1979 from Indiana University studying maternal effect genes in Drosophila. After almost 25 years of working with fruit flies, she switched to reptiles and amphibians as her emphasis switched to teaching undergraduates. She is the director of the BGSU Herpetarium, a private collections of reptiles and amphibians on loan to the university for teaching and research purposes.

Introduction

Reptiles and amphibians (aka "herps") seem to intrigue most students and thus can be used to engage students in a variety of biological principals, especially genetics. Bringing animals into the classroom, or having them reside at the back of the teaching lab, can be useful in grabbing the students' attention and interest. In this miniworkshop, a small number of animals were used to demonstrate how this has successfully accomplished at BGSU, both in the undergraduate General Genetics (BIOL350) course and in a non-majors Introductory Biology (BIOL104) course. Of course for this to work, the animals must be maintained successfully, so abbreviated care sheets, designed to be printed, laminated and attached to cages, have been included for the most readily available and easily maintained species.

Selected species

Corn Snakes (*Elaphe guttata*):

A great example of an easily maintained and easy to handle reptile is the North American corn snake, *Elaphe guttata*. The corn snake is one of the mainstays of the reptilian pet trade, coming in a variety of colors and patterns, many of which demonstrate classic Mendelian genetic inheritance principles. The color morphs, "normal", amelanistic (amel), anerythristic (anery), and snow can be used to dramatically illustrate monohybrid and dihybrid crosses and how phenotypes are formed. The color pattern of a normal corn snake is a mixture of black, red and white (Figure 1A). Unlike mammals, for whom the lack of black pigment (melanin) results in a white animal with red eyes, a corn snake lacking melanin (amelanistic) is red and white (Figure 1B). This is because reptiles possess three types of pigment cells, melanophores, xanthophores and iridophores. Melanophores contain brown/black pigments. Xanthophores contain red and yellow pigments. Iridophores contain crystals which diffract the light, resulting in iridescence. (Bechtel, 1995) So when black pigment is genetically removed, a predominantly red snake, an amelanistic snake (Figure 1B, referred to in the pet trade as a "red-albino") is generated. If the red pigment is genetically removed, a predominantly black snake, an anerythristic snake, (Figure 1C, referred to in the pet trade as a "black-albino"[1]) results. If both red and black pigments are removed a white snake, a snow corn (Figure 1D) is produced. Both amelanistic (red-albino) and anerythristic (black-albino) traits are governed by simple Mendelian recessive genes. So when a red-albino is crossed with a black-albino in a dihybrid cross, the resulting F_1 are all heterozygous for both traits and thus are "normal" in color. The F_2 produced by mating these individuals heterozygote for both traits will be 9 "normal", 3 red-albinos, 3 black-albinos, and 1 snow corn (Table 1).

In addition to demonstrating genetic principals, discussion on adaptation to the natural environment can be conducted by asking students how well they think each of the color morphs will survive in the wild. They normally reside in fields and open woodlands, where bright white or red would be highly visible to predators. If hatchlings are available, developmental changes in color can be demonstrated. Hatchlings start out very dark, with very little red obvious. They become brighter with each shed.

A B C D

Figure 1. Corn snake color morphs. Normal (A); amelanistic (red-albino, B); anerythristic (black-albino, C); snow (white, D).

Table 1. Corn Snake Dihybrid Cross

	R = red pigment B = black pigment			r = no red b = no black		
P	RR bb X rr BB red black					
F_1	Rr Bb X Rr Bb all "normal"					
F_2		R B	R b	r B	r b	F_2 Totals:
	R B	RRBB normal	RRBb normal	RrBB normal	RrBb normal	9 normal 3 red 3 black 1 snow
	R b	RRbB normal	RRbb red	RrbB normal	Rrbb red	
	r B	rRBB normal	rRBb normal	rrBB black	rrBb black	
	r b	rRbB normal	rRbb red	rrbB black	rrbb snow	

[1] This is a misuse of the term “albino,” which refers to the absence of black pigment, but it has become established in the pet trade. It may make a geneticist shudder, but it does make it easier for students to follow the genetics if the terminology stays simple – “black albino” is easier to remember than “anerythristic,” especially for non-majors.

Leopard Geckos (*Eublepharis macularius*) and Pictus Geckos (*Paroedura pictus*):

Leopard geckos and pictus geckos are two ground dwelling lizards which are good for beginners and lend themselves to demonstration of simple Mendelian genetic inheritance patterns in the classroom and also to simple, semester long (or continuing) projects in the teaching lab. **Leopard geckos** come in a variety of colors and patterns, the most common being high yellow (Figure 2A, normal, black spots on a yellow background), albinos (show pale banding but no black spots) and patternless (Figure 2B) similar to albinos in the lack of black spots, but have a dark eye and no bands). The lack of black pigment in both albinos and patternless is due to separate recessive mutations. Leopard geckos exhibit temperature-dependent sex determination, with excess females produced at both high and low egg incubation temperatures and more males produced at intermediate temperatures. Students tend to be intrigued by this phenomenon (also found in crocodilians, turtles and several, but not all, species of lizard), and a discussion of the implications of environmental changes (e.g., global warming) on the survival of this species frequently leads to speculation about the demise of the dinosaur.

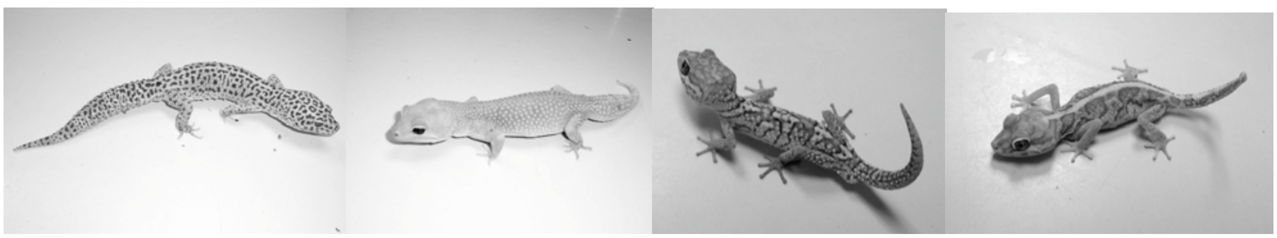
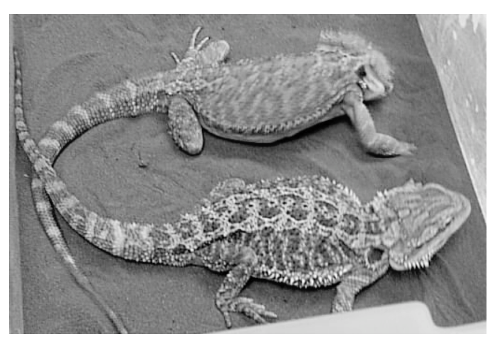

A B C D

Figure 2. Leopard gecko patterns: (A) normal high yellow, and (B) patternless. Pictus gecko color and pattern: (C) normal marble, and (D) xanthic stripe.

Pictus geckos are small, prolific lizards which come in both the "normal" color of black on gray background and a lighter yellow color referred to as xanthic (Figure 2C). They are also found in either striped or banded patterns (Figure 2D) Xanthic is recessive to the normal and striped is recessive to banded. These little lizards are great teaching laboratory inhabitants. They do not need much space, are easily maintained (eating primarily crickets) and readily breed, laying a pair of hard-shelled eggs at 2-4 week intervals. The eggs hatch in six to ten weeks (depending upon incubation temperature). Students can thus watch the entire life cycle in a single semester, and can make periodic behavioral observations along the way. As they are relatively short lived (2-4 years) and prolific (a single female will lay 30-50 eggs in a year) and exhibit no parental care, they can be used to initiate discussions of r-selected and K-selected life history strategies. They are also simply fun to watch, especially at feeding time.

Bearded Dragons (*Pogona vitticeps*) and Crested Geckos (*Rhacodactylus ciliatus*):



Bearded dragons (picture to the right) and crested geckos are two lizards which exhibit stereotypic behavior patterns, and thus are useful for enriching discussions on animal behavior. If both are available, they can be used to demonstrate adaptations for different environments. Bearded dragons are a terrestrial, diurnal, desert dwelling lizard from

Australia. Crested geckos (picture to the right) are semi-arboreal, nocturnal lizards found in moist primary forests in New Caledonia. Genetic traits are now being selected for in both lizard species, but so far color and pattern seem to involve multimedia inheritance patterns. In both of these species color also changes within a limited range. When individuals are cold they tend to be darker (presumably to assist in absorbing heat from the sun). Color changes also seem to be affected by mood, with "stressed" animals being the most brightly colored. In this instance, stress is defined by the need for territorial displays, or mating behaviors.

Many other reptiles and amphibians lend themselves to demonstrating biological principals in the classroom and in teaching laboratories. Care sheets for several of these are listed on the BGSU Herpetarium web site: www.bgsu.edu/departments/biology/facilities/herp/ .

Captive Care Instructions

Captive care instructions and a detailed list of references for each species are available on the BGSU Herpetarium web site: www.bgsu.edu/departments/biology/facilities/herp/ .

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