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Science

Variation and Selection in the Egyptian Origami Bird (*Avis papyrus*)

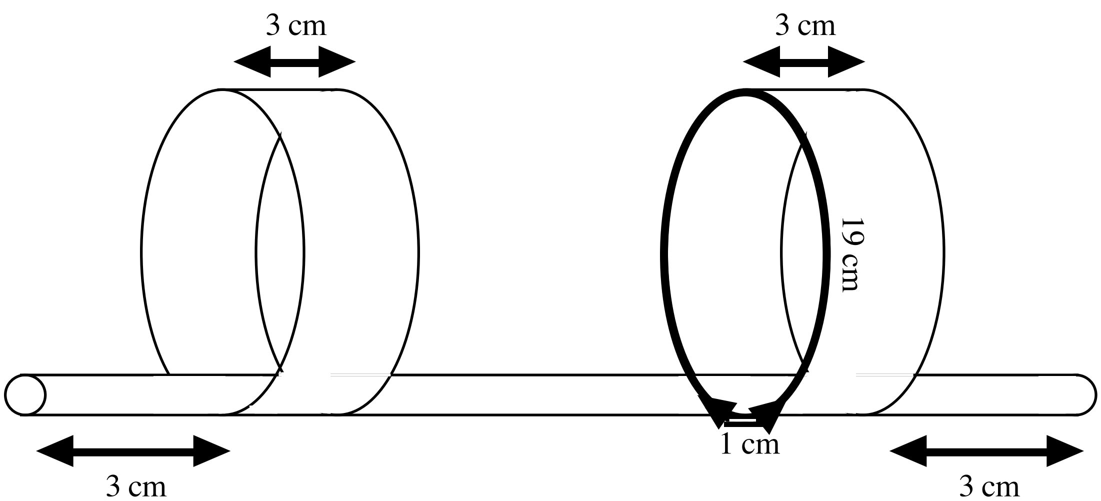
INTRODUCTION: The Egyptian Origami Bird (*Avis papyrus*) lives in arid regions of North Africa. It feeds on prom dates (*Palmus juniorseniorus*) and drinks from Palm Springs. Only those birds which can successfully fly the long distances between the sparsely spaced oases will be able to live long enough to breed successfully. In this lab you will breed several generations of Origami Birds and observe the effect of various genotypes on the evolutionary success of these animals.

MATERIALS: Paper, tape, straws
Scissors
Coin, six-sided die

METHOD:

1. Prepare ancestral bird:

   Cut two strips of paper, each 3 cm x 20 cm.
   Loop one strip of paper with a 1 cm overlap and tape. Repeat for the other strip.
   Tape each loop 3 cm from the end of the straw.



2. Breed offspring. Each Origami Bird lays a clutch of three eggs.
   Record the dimensions of each chick and hatch the birds using these instructions:

   a. The first egg has no mutations. It is a clone of the parent.
      In the interest of time you may substitute the parent when testing this chick.

   b. The other two chicks have mutations.
      For each chick, flip your coin and throw your die then record the results on the table.

      i. The coin flip determines where the mutation occurs: the head end or tail end of the animal:

Heads = head, or cephalic, end

Tails = tail, or caudal, end

ii. The die throw determines how the mutations effects the wing.

1 = The wing moves 1 cm *toward* the end of the straw.

2 = The wing moves 1 cm *away* from the end of the straw.

3 = The circumference of the wing *increases* 2 cm.

4 = The circumference of the wing *decreases* 2 cm.

5 = The width of the wing *increases* 1 cm.

6 = The width of the wing *decreases* 1 cm.

iii. Lethal mutations:

A mutation which results in a wing falling off the end of straw, or in which the circumference of the wing is smaller than the circumference of the straw, etc. is lethal. Fortunately, *Avis papyrus* birds are known to "double clutch" when an egg is lost. If you should get a lethal mutation, disregard it and breed another chick.

3. Test the birds.

   Release the birds with a gentle, overhand pitch.
   It is important to release the birds as uniformly as possible.
   Test each bird twice.

4. The most successful bird is the one which can fly the farthest.
   Mark which chick was the most successful on the table.

5. The most successful bird is the sole parent of the next generation.
   Continue to breed, test, and record data for as many generations as you can in the time allotted.

RESULTS:

Use the table to record the results of your coin flips and die throws, the dimensions of all chicks, and the most successful bird in each generation.

DISCUSSION:

Answer the questions. Use complete sentences.

1. Did your experiment result in better flying birds?

2. Evolution is the result of two processes: variation and selection.
   a. How did your experiment produce variation among the offspring?
   b. How did your experiment select offspring to breed the next generation?

3. Compare your youngest bird with your neighbor's youngest bird.
   a. Compare and contrast the wings of of other birds with your own.
   b. Explain why some aspects of the birds are similar.
   c Explain why some aspects of the birds are different.

4. Predict the appearance of your youngest bird's descendants if. . .
   a. the selection conditions remain the same and the longest flying bird survives to produce the most offspring.
   b. the selection conditions change the worst flying bird survives to produce the most offspring.
   c. the selection conditions change and the bird whose color blends with its environment survives to produce the most offspring.

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Origami Bird Data Sheet

Flip coin, throw die, record results. Plan the baby chicks, record their dimensions, breed the chicks.

Generation 0	NO mutation: 3 x 20 3 x 20 Head Tail 3 cm 3 cm	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______

Mark the winning bird. Only the most successful bird becomes a parent of the next generation. The "no mutation" chick in the next generation is identical to the winning bird in the *immediately* preceding generation. Continue to flip and throw, plan chicks, breed them, and test them for more generations.

Generation 1	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 2	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 3	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 4	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 5	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 6	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______
Generation 7	NO mutation: ___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______	Coin Die	___ x ___ ___ x ___ Head Tail ______ ______

1. Did your experiment result in better flying birds?

   Most students will answer "yes."

2. Evolution is the result of two processes: variation and selection.
   a. How did your experiment produce variation among the offspring?

   Mutation of wing length, width, and position cause variation among babies.

   b. How did your experiment select offspring to breed the next generation?

   Only the best fliers had opportunity to breed, offspring's characteristics are similar to selected parents.

3. Compare your youngest bird with your neighbor's youngest bird.
   a. Compare and contrast the wings of of other birds with your own.

   The best fliers usually have smaller circum-ference, narrow wings at the front (cephalic) end & larger, wider wings near the back (caudal) end.

   b. Explain why some aspects of the birds are similar.

   There were similar selection conditions for all birds. Only birds who flew longest distance had an opportunity to breed.

   c Explain why some aspects of the birds are different.

   Mutations are random. Nobody chose which mutations happened.

4. Predict the appearance of your youngest bird's descendants if. . .
   a. the selection conditions remain the same, the longest flying bird survives and reproduces.

   Bird flight distance continues to improve.

   b. the selection conditions change: the worst flying bird survives to produce the most offspring.

   Birds which fall out of the sky the way bricks do will breed more often. Eventually, have mostly broad-winged, poor flying offspring.

   c. the selection conditions change and the bird whose color blends with its environment survives to produce the most offspring.

   More blending parents escape predators and live to reproduce. More blending babies hatch. Selection for long distance fliers continues.

EXTENSION:

Breed birds for *one* of these scenarios:

A. A flock of Origami Birds is blown off the mainland and onto a very small Mediterranean island. There are no predators here. Like the flightless fruit flies (*Drosophila* spp.) of Hawaii and the Dodo (*Raphus cucullatus* and *Didus ineptus*) before the arrival of humans on Mauritius and Réunion, these birds face little danger on the ground, but experience significant risk when flying, since they can be blown off the island. The best survival strategy for these birds is not to fly at all. Continue the experiment for several generations selecting for birds which drop out of the sky the way bricks do.

B. Another flock of Origami Birds is blown onto a different, somewhat larger, island. Silver Scissor Foxes (*Vulpes cisoria* ssp. *argentatum*) live on this island, so birds which cannot fly will be eaten. The best survival strategy for these birds is to fly in boomerang or loop-the-loop curves. Birds which fly straight might drift off the island and be swept away. Continue the experiment for several generations selecting for curved flight.

C. Your Origami Bird remained on the mainland where a drought is occurring. Only those birds which can fly straight and far between oases will survive. Continue the experiment for several more generations while selecting for the characteristics which result in the most appropriate flight behavior.

QUESTIONS:

5. Compare your youngest bird with the youngest birds from neighboring groups with the same scenario.

6. Compare your youngest bird with the youngest birds from neighboring groups with different scenarios.

7. How might this lab help explain the observations Darwin made about finches in the Galapagos?

5. Compare your youngest bird with the youngest birds from neighboring groups with the same scenario.

The student's bird may resemble its neighbors in several aspects. This is an example of convergent evolution. However, there may be differences. Whatever is discovered, the student should report the result.

6. Compare your youngest bird with the youngest birds from neighboring groups with different scenarios.

Hopefully, students will notice a difference between birds bred in different environments. This is an example of divergent evolution.

7. How might this lab help explain the observations Darwin made about finches in the Galapagos?

The finches on the different islands lived in different environments. Offspring lucky enough to inherit genes appropriate for the situation produced the most offspring.

1. Did your experiment result in better flying birds?

Write down what YOU got: yes, no, maybe.
Use a complete sentence.

2. Evolution is the result of two processes: variation and selection. .
   a. How did your experiment produce variation among the offspring? .

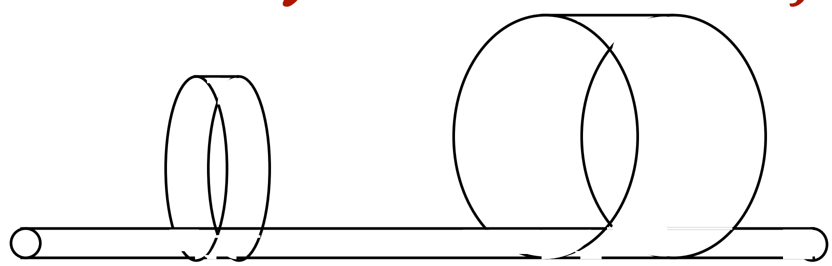
Dice used for RANDOM CHANGE of
WING: length, width, position.

   b. How did your experiment select offspring to breed the next generation? .

Selected BEST flier to be
PARENT of next generation

3. Compare your youngest bird with your neighbor's youngest bird. .
   a. Compare and contrast the wings of of other birds with your own. .

Best fliers usually have small head, big bottom



   b. Explain why some aspects of the birds are similar. .

Common ancestor.
Similar selection condition: long flight.

   c Explain why some aspects of the birds are different. .

Mutations are random: different flips/tosses.

4. Predict the appearance of your youngest bird's descendants if. . . .
   a. the selection conditions remain the same, the longest flying bird survives and reproduces. . .

Flight distance improves: go farther.

   b. the selection conditions change the worst flying bird survives to produce the most offspring. .

Over time (eventually) get non-flying birds. . .

   c. the selection conditions change and the bird whose color blends with its environment survives to . produce the most offspring. .

Blending parents hide, escape predators.
Blenders live to reproduce, make blend babies.
Eventually get many camouflaged birds.
(Selection for long distance fliers continues.) .