Introduction: Say Hello to the Junco

Education overview

What makes the "Ordinary Extraordinary Junco" film project unique?

So often nature and science films focus on exotic or alluring organisms in far-off tropical rainforests, polar icecaps, or deep-ocean reefs.
In contrast, *Juncos* are among the most common and abundant "backyard birds" found across North America and are easily observable by millions of people daily. We love these shows, too! **But we wanted people to realize that exciting biology, including evolution, is happening every day in their own backyards.** Also, we wanted to share the scientific research process with public and student audiences.

This documentary film covers a wide variety of topics required for high school and college biology classrooms through engaging students in the story of the *Juncos*. Research surrounding this group of species can teach students about diverse topics in biology, including: evolution, ecology, animal behavior, hormones and physiology, genetics, and the process of science. In the provided Teacher Guides, we have aligned the film modules with both sets of national science teaching standards and provided some sample questions for student handouts. The standards listed below are addressed throughout the documentary chapters (8 total, Intro, Chapters 1-6, and Outro), which range in length from 3 to 20 min. (88 min. total).

We view these educational resources as an "open-source" project.
These initial resources that we have developed are to encourage and facilitate use of the film by educators, but we welcome any and all feedback and contributions to expand, refine, create, and share new materials to accompany our film project. Please don't hesitate to be in contact if you have ideas of how to improve our project's effectiveness or have developed materials you are willing to share (juncoproject@gmail.com).

Say Hello to the Junco (2:54) (1 of 8)

Introduce yourself to one of North America's most common and abundant groups of songbirds, the *Juncos* ! Easily observed in backyards, city parks, and forests alike, these little gray birds---sometimes called "Snowbirds"---can be easily overlooked. But for scientists who study animal behavior, ecology, and evolutionary biology, the *Junco* is a "rockstar." This segment serves as a preview for our feature-length (88 min.) film project, which is comprised of shorter modules (4 to 18 min.) designed to bring to life more than 100 years of groundbreaking research on the "*Ordinary Extraordinary Junco*."

This short introduction will prepare students for the topics of study to come in documentary.

Keywords:

adaptation; animal behavior; behavior; behavioral ecology; biology; bird; birds; Dark-eyed Junco; climate change; DNA; divergence; diversity; diversification; documentary; ecology; evolution; evolutionary biology; gene; gene sequence; genetics; Indiana University; intro; junco; *Junco*; Ketterson, Ellen; mate choice; Mila, Borja; natural selection; nature; ornithology; phenotype; phylogeny; phylogenetics; physiology; Rowan, William; science; scientific method; sexual selection; social behavior; snowbird; songbird; speciation; species; species concepts; testosterone; trailer; Yellow-eyed Junco; urbanization

National Academies Science Standards
For a copy of these standards see:
http://www.nap.edu/openbook.php?record_id=4962

See pages: Overall - 106, table 6.3; 108, table 6.7
Specific Content – pages 111- 119 – biological evolution, behavior of organisms, science as a human endeavor, nature of scientific knowledge, historical perspectives, evolution and equilibrium; page 185 – biological evolution; page 187 – behavior of organisms; page 200 – science as a human endeavor; page 201 – nature of scientific knowledge.

AAAS – Benchmarks in Science
Standards website: http://www.project2061.org/publications/bsl/online/index.php

The Nature of Science: 1A/H2, 1A/H3a, 1A/H3bc, 1A/H3d
Scientific Inquiry: 1B/H1, 1B/H2, 1B/H3, 1B/H4, 1B/H7
The Scientific Enterprise: 1C/H6ab
The Living Environment: A. Diversity of Life: 5A/H2, 5A/H5; B. Heredity: 5B/H2, 5B/H7; D. Interdependence of Life: 5D/H2, 5D/H3; F. Evolution of Life: 5F/H1, 5F/H2, 5F/H3, 5F/H4a, 5F/H4b, 5F/H6a, 5F/H6c, 5F/H9, 5F/H10

Introduction: Say Hello to the Junco

Name: _____

Directions: Watch the video clip "Introduction: Say Hello to the Junco" and answer the questions below in the space provided.

1. List at least two different places that *Juncos* live.

Appalachian mountains of Virginia, Black Hills of South Dakota, Grand Tetons in Wyoming, highlands of Guatemala, mountains of Baja, remote island off the coast of Mexico

2. What is one of the biggest questions in evolutionary biology?

How are species formed? (And what are the relative roles of natural and sexual selection.)

Critical Thinking Question

3. Why do you think the *Junco* would be a good species for studying evolution? What about for studying animal behavior?

4. Why might biologists want to study birds or other animals, in order to learn about human biology?

Rowan and the Junco: Pioneers in Science

Chapter 1

Run Time - (4:54)

William Rowan was an early 20th century immigrant to Canada who became one of his era's most famous scientists through research on the Dark-eyed Junco. Before Rowan, it was unknown what environmental cues animals used to time the seasonal changes in their biology. How do animals know when it is time to migrate or breed each year? Through a groundbreaking experiment with juncos, Rowan discovered "photoperiodism" for the first time in animals---but his success didn't come easily! Shot as a historical re-enactment, this segment provides a glimpse into the history and human dimensions of scientific research, conveys the scientific method, and reveals one of the first studies that made juncos well known to biologists.

This chapter will give students a historical perspective on the process of science. The nature and process of the scientific endeavor is shown through chronicling the life of the ornithologist, William Rowan, and the conception and completion of an experiment from start to finish. After viewing this chapter students may realize that scientists can encounter difficulties from many avenues, including challenging cultural expectations and pre-existing ideas. In addition, the historical perspective as to how the Dark-eyed Junco came to be a study organism sets the stage for student understanding of recent scientific research covered in subsequent chapters. Students will also get a glimpse of how environmental cues can influence animals' physiology and behavior. Specific national standards are listed below.

Keywords: adaptation; aviary; barometric pressure; behavior; biology; bird; birdsong; breeding; Dark-eyed Junco; discovery; endocrinology; environment; experiment; gonads; historical re-enactment; history; human dimensions; junco; *Junco*; migration; ornithology; ovaries; perseverance; phenology; photoperiod; physiology; pressure; reproduction; re-enactment; Rowan, William; scientific method; season; seasonality; season; song; temperature; testes; timing; University of Alberta; zoology;

National Academies Science Standards
For a copy of these standards see: http://www.nap.edu/openbook.php?record_id=4962

Page 108, Table 6.7; Pages 111 – 119, History and Nature of Science; Page 200, Science as a human endeavor; Page 201, Nature of scientific knowledge

AAAS – Benchmarks in Science
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Scientific Inquiry: 1B/H1, 1B/H2, 1B/H3, 1B/H4, 1B/H7

Rowan and the Junco: Pioneers in Science

Chapter 1

Name: _____

Directions: Watch the video clip "Rowan and the Junco: Pioneers in Science" and answer the questions below in the space provided.

1. Which two biological cues were thought to trigger the migration of birds prior to Rowan's experiment?

Temperature and barometric pressure

2. What hypothesis did Rowan test to determine the biological cue that triggers bird migration?

He hypothesized that change in day length triggered the birds to migrate.

3. What was the result of Rowan's study?

He found that experimentally increasing day length (to simulate what would happen naturally in the spring) caused bird gonads to increase in size and male birds to sing—despite winter-like temperature, snowfall, and other environmental factors.

Critical Thinking Questions

4. What challenges did Rowan face when he was conducting his research? What do you think that can teach us about determination and passion?

5. Many animals, such as sea turtles, elk, and fish, migrate. Think of one other hypothesis that may contribute to a different species' migration other than day length and write it below.

6. Under what circumstances could the length of days be a "misleading" cue for animals to use when timing seasonal events like migration or breeding?

Appalachian Spring: Long-term Studies at Mountain Lake

Chapter 2

Run Time – 18:01

For nearly 40 years, Dr. Ellen Ketterson and her research team from Indiana University have been studying Dark-eyed Juncos in the mountain forests of Virginia. This segment introduces viewers to the junco, the researchers, and the core methods they use to study birds. Set in field, lab, and aviary locations, one landmark study is highlighted in detail: a long-term field experiment investigating the hormone testosterone's complex effects on behavior, physiology, and evolutionary fitness.

Through illustrating the work of many modern-day scientists who have all been under the direction of Dr. Ellen Ketterson, students will gain a greater understanding of how hormones can influence many physical and behavioral traits. By studying this example, students will learn how many scientific studies raise more questions and lead to more experiments. Students will understand how one hormone may have an effect on multiple characteristics within an organism and how these alterations may influence evolutionary trajectory. Additionally, basic field biology and ornithology methods that the scientists use to study birds are highlighted including mist-netting, bird banding, measuring, collecting blood samples, and paternity testing.

Keywords:

adaptation; aggression; Appalachian Mountains; behavior; behavioral endocrinology; biology; bird; birdsong; DNA; endocrinology; evolution; experiment; extrapair behavior; extra-pair behavior; genetics; hormone; Indiana University; junco; *Junco*; *Junco hyemalis*; *Junco hyemalis carolinensis*; Ketterson, Ellen; long-term research; mating success; McGlothlin, Joel; mist net; mist-net; monogamy; Mountain Lake; natural selection; nest; nesting; ornamentation; ornithology; parental care; parenting; paternity; phenotype; plumage; scientific method; sexual selection; Snajdr, Eric; songbird; steroids; survival; adaptation; tail white; testosterone; University of Virginia; Virginia

National Academies Science Standards

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Page 106, Table 6.3; Page 108, Table 6.7; Pages 111 – 119, biological evolution, behavior of organisms, science as a human endeavor, nature of scientific knowledge, historical perspectives, evolution & equilibrium; Page 185 – biological evolution; Page 187 – behavior of organisms; Page 200 – science as a human endeavor; page 201 – nature of scientific knowledge

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The Living Environment
B. Heredity: 5B/H7
F. Evolution of Life: 5F/H3, 5F/H4b

Appalachian Spring: Long-term studies at Mountain Lake

Chapter 2

Name: _____

Directions: Watch the video clip "Appalachian Spring" and answer the questions below in the space provided.

1. When is the best time of day to observe the dark-eyed junco in the field?

morning

2. What are at least two reasons why the junco makes a good research species?

Answer can be any one of the following: They live on the ground so they are easy to access, they thrive in captivity, they are content to live in captivity, researchers can study them in natural aviaries – which allows them to manipulate many different variables such as day length.

3. What allows researchers to identify individual birds and tell one junco from another?

Colored bands on their legs

4. How do experimental males (added testosterone) compare to control males in the amount of singing and size of territory they hold?

Higher testosterone males hold larger territories and sing significantly more often than control males.

5. How did testosterone impact the mating behavior of the experimental males (added testosterone) when compared to the control males?

They mated with more females that were not their social partner. They are more promiscuous than control males.

6. How did high testosterone impact male survival and quality of the care to their offspring?

High testosterone males had shorter lives and had lower quality offspring as a result of their lack parental care.

Critical Thinking Questions

7. If the juncos experience particularly difficult conditions during a breeding season (i.e. lack of water/food), make a prediction as to whether the offspring from higher or lower testosterone males will survive best. Support your prediction with data presented in the movie.

8. Based on your thoughts from the above prediction, how do you think that would impact the evolution of the dark-eyed junco? (Hint: think about which offspring will survive and if the offspring will be more likely to have higher or lower amounts of testosterone.

Diversification I: the Dark-eyed Juncos

Chapter 3

Run Time - 14:13

Throughout North America, the species known as the "Dark-eyed Junco" exhibits striking differences in feather color, body size, and behavior from place to place. This variation among "subspecies" and "races" of juncos has caught the attention of biologists interested in diversification, evolution, and speciation---the process by which new species form. Exploring the definition of 'species,' hybridization, and the role of new DNA technology in studying evolution, this segment features footage from junco habitats across the continent. From Dr. Alden Miller in the 1920s, to Dr. Borja Mila, a modern day explorer and ornithologist, join researchers on their quest to understand the riddle of the *Junco*'s evolutionary history.

In this segment students will gain a greater understanding of the definition of 'species' through considering both traditional definitions such as the Biological Species Concept (BSC), which focuses on animals' ability to interbreed in nature---as well as through learning how modern scientists use DNA to assist with understanding the extent and historical timing of divergence and diversification among populations of organisms. An example of hybridization among two Dark-eyed junco groups that look quite different is illustrated, revealing that physical characteristics like color, shape, or size, may be misleading in understanding evolutionary similarity and relatedness. In addition, an example simple phylogenetic tree (i.e., an 'evolutionary tree' is constructed from genetic sequence data to illustrate how scientists use this tool as a model to understand evolutionary history and relatedness. This segment also illustrates a phylogenetic "tree" (or bush!) among the closely related Dark-eyed Junco groups based on actual DNA analyses, along with a comprehensive hypothesis explaining the diversity across the continent.

Keywords: adaptation; Biological Species Concept (BSC); Black Hills; biology; bird; cytochrome oxidase; Dark-eyed Junco; differentiation; divergence; diversification; diversity; DNA; evolution; evolutionary tree; feathers; feather color; gene; gene sequence; genetics; Grand Teton National Park; Gray-headed Junco; Indiana University; junco; *Junco*; *Junco aikeni*, *Junco caniceps*; *Junco hyemalis*; *Junco mearnsi*; *Junco oreganus*; Mila, Borja; Miller, Alden; molecular clock; morphology; Mt. Charleston, Nevada; Museo Nacional de Ciencias Naturales; Oregon Junco; ornithology; phenotype; phylogenetic tree; phylogeny; phylogeography; Pink-sided Junco; plumage; races; radiation; sequencing; San Diego Museum of Natural History; Slate-colored Junco; South Dakota; speciation; species; species concepts; subspecies; Unitt, Phil; University of California-Berkeley; White-winged Junco;

National Academies Science Standards

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AAAS – Benchmarks in Science

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The Nature of Science: 1A/H2, 1A/H3a, 1A/H3bc, 1A/H3d
Scientific Inquiry: 1B/H2, 1B/H4, 1B/H7
The Living Environment
A. Diversity of Life: 5A/H2, 5A/H5
B. Heredity: 5B/H2, 5B/H7
F. Evolution of Life: 5F/H1, 5F/H2, 5F/H4a, 5F/H9

Diversification I: the Dark-eyed Juncos

Chapter 3

Name: _____

Directions: Watch the video clip "Diversification I: the Dark-eyed Junco" and answer the questions below in the space provided.

1. What physical characteristics distinguish various groups of the Dark-eyed Junco?

Plumage coloration particularly on the breast, back, sides, tail, and head (hood)---and body size

2. What characteristics are shared among various breeding habitats?

trees, shade, grass, and ground cover for nesting and foraging

3. How many distinct groups of juncos were identified by Alden Miller?

21 distinguishable types or groups altogether across the continent----but the dark-eyed juncos in the north (US and Canada) can be "binned" into 6 major morphs/subspecies

4. If different dark-eyed juncos look so different why are they classified as a single species?

Because where the different groups' ranges meet, they can often interbreed and produce fertile offspring.

5. How do modern scientists determine the degree of relatedness between groups of animals?

DNA is analyzed to determine the amount of differences in the DNA sequence.

6. In the phylogenetic tree provided as an example, which two groups are most closely related? Why?

Group C and D are the most closely related because they have the most similar DNA sequences.

7. Based on DNA sequence differences, approximately how long ago did the six main groups of Dark-eyed diverge from one another?

Just a few thousand years ago. Very recently in evolutionary time. Since the last "Ice Age"

Critical Thinking Questions

1. Formulate a hypothesis (a possible explanation) as to why the six different groups of Juncos vary so greatly in plumage color.

2. Provide at least one idea as to how you might test the hypothesis you came up with.

3. Based on the evidence presented, what biological process do you think has contributed towards populations diverging in physical characteristics? Explain why you think that process is responsible for these differences.

4. One million years from now, do you think there will still be 6 distinct groups of Dark-eyed Juncos? More? Fewer? Why or why not?

5. Explain how phylogenetic trees are made. Why do you think biologists construct phylogenetic trees?

Diversification II: South of the Border

Chapter 4

Run Time - 18:05

Less familiar to residents of the US and Canada are several *Junco* groups that inhabit the highlands of Mexico and Central America. Building upon findings revealed in "Diversification I: the Dark-eyed Juncos," join researchers from around the world as they travel to remote high elevation habitats to study unique juncos found there. Exploring the concepts of endemism, geographic isolation, and the role genetic data in classifying species and determining evolutionary relatedness, this segment is characterized by stunning scenery, local culture, and a close-up look at birds and habitats that few have had the opportunity to see.

Geographic isolation can play a key role in speciation. In this segment students will study this important concept through learning about several endemic populations of juncos, found nowhere else in the world. In addition, building off of the previous segment (Diversification I), students will continue to learn about how genetic data can be used to determine how closely related these groups might be, including whether they might be considered separate species---especially when it is impossible to tell whether isolated populations would interbreed if given the chance. Species classification is important because it can impact environmental and legal protection of these birds, including conservation the small isolated forest habitats in which they live. Students will also learn about how local human activities can have an impact on the habitats that surround them.

Keywords: adaptation; Atwell, Jonathan; Baja Junco; Baja Sur; Baja; biology; bird; birds; birdsong; coloration; Dark-eyed Junco; divergence; diversification; diversity; DNA; El Ajusco; endangered species; endemic; endemism; evolution; evolutionary tree; feather color; genetic distance; genetics; geographic isolation; Gloger's Rule; Guatemala; Guatemala Junco; Huehuetenango; Indiana University; insular tameness; junco; Ketterson, Ellen; *Junco alticola; Junco hyemalis; Junco bairdii; Junco phaeonotus; Junco;* Mila, Borja; McCormack, John; Mexico; Mexico City; morphology; Museo de Ciencias Naturales; natural selection; Occidental College; ornament; ornithology; phylogeny; phylogenetic tree; phylogenetics; phylogeography; plumage; sexual selection; San Cristobal; Sierra de La Laguna; sky island; song; species; Todos Santos; species concepts; speciation; species; sub-species; Yellow-eyed Junco;

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The Living Environment
A. Diversity of Life: 5A/H2, 5A/H5
B. Heredity: 5B/H2, 5B/H7
F. Evolution of Life: 5F/H1, 5F/H2, 5F/H4a, 5F/H9

Diversification II: South of the Border

Chapter 4

Name: _____

Directions: Watch the video clip "Diversification II: South of the Border" and answer the questions below in the space provided.

1. How many distinct groups of clearly distinct yellow-eyed juncos exist?

three

2. What tasks must scientists complete to collect DNA and data on physical traits?

1. capture birds
2. take measurements and blood samples
3. place aluminum band to maintain bird identification

3. Why do juncos sing?

attract mates and announce territories

4. What are endemic groups?

are unique populations or varieties of animals that only exist in one particular area and no where else in the world

5. Why is it important to determine whether populations are different species?

It is important because certain small populations may gain legal protection of themselves and their habitats if they are considered a separate species that is threatened or endangered with extinction.

6. How did the birds in the highlands of Baja, Mexico differ in physical traits when compared to other populations? What about in their behaviors?

they are smaller and paler in color; they seemed to be more tame or bold;

7. What did the genetic analysis indicate with regard to amount of genetic differentiation among the three yellow-eyed junco groups?

There were many genetic differences, indicating they have been on separate evolutionary trajectories (or branches) for hundreds of thousands of years. Based on these genetic data, each group should be classified as its own species.

Critical Thinking Questions

8. How do human culture and lifestyle impact natural habitats?

9. Write at least two hypotheses as to how human culture and lifestyle may influence junco evolution.

10. One million years from now, how many distinct groups of yellow-eyed juncos are likely to exist? More? Fewer? Why or why not?

The Mysterious Juncos of Guadalupe Island

Chapter 5

The Mysterious Juncos of Guadalupe Island (11:21)

Continuing the journey begun in "Diversification I" and "Diversification II," this segment opens with researchers hitching a ride with the Mexican Navy to visit a breathtakingly beautiful but critically endangered island habitat. Led by Drs. Borja Mila and Ellen Ketterson, the team sets out to collect some of the first modern data and genetic samples from the juncos found on the remote island, with the goal of learning the origins and evolutionary history of this mysterious *Junco*. What they find could have important implications for the future of this fascinating but imperiled population of birds.

In this segment students will learn more about another endemic population through studying a remote group of juncos on Guadalupe Island. Geographic isolation can contribute to speciation and lead to endemism, giving rise to a strong need for conservation and protection of island habitats. In addition, students will follow researchers as they travel to this remote island and gain a greater appreciation for doing fieldwork in remote locations. As the results of a genetic analysis are discussed, it is revealed how physical traits like color, shape, or size can be misleading in understanding evolutionary relationships----as it turns out the identity of the Guadalupe Junco's closest relative is unexpected. Further, the concept of using the amount of genetic divergence (sequence differences) to determine whether isolated populations might be considered unique and independent species on their own evolutionary trajectories is revisited.

Keywords: adaptation; albatross; Aguirre, Alfonso; Atwell, Jonathan; Baja; beak; bill shape; biology; bird; birds; birdsong; Cypress; differentiation; divergence; diversification; diversity; DNA; ecology; endemic species; endemism; Ensenada; evolution; evolutionary history; evolutionary tree; exotic species; feather color; feral; fire; goats; Groupo Ecologico de Conservacion de Islas; Guadalupe Island; Guadalupe Fur Seal; Guadalupe Junco; Indiana University; invasive species; Isla Guadalupe; island biogeography; island conservation; junco; *Junco insularis*; *Junco;* Ketterson, Ellen; Mexico; Mila, Borja; morphology; Museo Nacional de Ciencias Naturales; natural selection; nature; ornament; ornithology; phylogeny; plumage color; plumage; sexual selection; song; songbird; speciation; species concepts; species;

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F. Evolution of Life: 5F/H1, 5F/H2, 5F/H4a, 5F/H6a, 5F/H6c, 5F/H9, 5F/H10

The Mysterious Juncos of Guadalupe Island

Chapter 5

Name: _____

Directions: Watch the video clip "The Mysterious Juncos of Guadalupe Island" and answer the questions below in the space provided.

1. How long did it take the research team traveling by boat at 30 knots to get to Guadalupe Island?

Nearly 24 hours

2. Approximately how old is Guadalupe Island?

8 million years old

3. Approximately how big is the Junco population in the cypress forest?

A few hundred breeding pairs (inhabit 300 Acres).

4. What did the genetic analysis of the juncos on Guadalupe Island reveal?

The Guadalupe Junco is most closely related to the Guatemalan Juncos (despite the fact that they don't look that similar at all). And the Guadalupe Junco is very different genetically and should be classified as its own species.

5. What is Dr. Borja Mila's hypothesis as to why the Guadalupe Island Juncos have a more "pointy" or more "tweezer-like" beaks?

His hypothesis is that the seedpods of the Cyprus trees may have led to the evolution of the unique beak shape.

Critical Thinking Questions

6. How can introduced species (species that are not native to an area) impact local endemic species?

7. The researchers collected and analyzed genetic data that found the Guadalupe Island Juncos to be a separate species. What impact does that have on Guadalupe Island Junco conservation?

8. Explain what effect protecting the cypress forest may have on other species that also inhabit it.

Evolution in Action: the Campus Juncos at UCSD

Chapter 6

"Evolution isn't something that happened a long time ago, it is something that happens everyday." ~Dr. Phil Unitt

Curator of birds and mammals at the San Diego Natural History Museum

Run Time – 16:02

In stark contrast to the peaceful wildlands featured in the prior segments, the urban campus of the University of California-San Diego (UCSD) seems like an unlikely place to find field biologists studying Juncos. But in the early 1980s, some juncos decided to make this atypical urban and coastal habitat their year-round home. Since then, scientists have documented a remarkable array of changes in the physical traits, behaviors, and physiology of the "colonist" population of Juncos at UCSD when compared to Juncos from the nearby native range.

The Juncos of UCSD are a perfect example of rapid evolution. In this segment students will learn about how researchers can use genetic tools to study a recently settled population to determine the amount of change that has occurred. In addition, scientists have conducted a common garden experiment, which has shown that genetic changes in this population correlate with multiple differentiated phenotypes. During this segment students will learn about what a common garden experiment is and why scientists may use such an experimental design.

Keywords: adaptation; aggression; animal personality; Atwell, Jonathan; behavior; behavioral ecology; behavioral endocrinology; biology; bird; birds; bold; boldness; breeding phenology; breeding season length; climate change; common garden; contemporary evolution; corticosterone; divergence; diversification; DNA endocrinology; evolution; evolution-in-action; exploratory behavior; feather color; flight-initiation-distance; flush distance; gene sequence; genes; genetics; head black; Indiana University; *Junco hyemalis thurberi;* Junco; *Junco;* Ketterson, Ellen; La Jolla; Mount Laguna; Mt. Laguna; natural selection; nest; nesting; Oregon Junco; ornithology; parental behavior; parental care; parenting; personality; phenology; plumage; Price, Trevor; rapid evolution; San Diego Natural History Museum; seasonality; sexual selection; shy; shyness; song frequency; song; songbird; stress; stressors; tail white; testosterone; timing; UCSD; Unitt, Phil; University of California-San Diego; urban ecology; urbanization; Walens, Stan; Yeh, Pamela;

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The Living Environment
- *A. Diversity of Life*: 5A/H2, 5A/H5
- *B. Heredity*: 5B/H7
- *D. Interdependence of Life*: 5D/H3

F. Evolution of Life: 5F/H1, 5F/H2, 5F/H4a, 5F/H6a, 5F/H6c, 5F/H9, 5F/H10

Evolution in Action: the Campus Juncos at UCSD

Chapter 6

Name: _____

Directions: Watch the video clip "Evolution in Action: the Urban Juncos at UCSD" and answer the questions below in the space provided.

1. What is different about the migration habits of the UCSD population compared to the Mount Laguna population?

They don't migrate.

2. When was UCSD built?

1960's

3. When was the first sighting of Juncos on the UCSD campus?

1983

4. How does the habitat on the UCSD campus differ from that of remote mountain habitats?

Vehicles, humans, domestic animals, predators, constant noise, artificial light, consistent sources of food, bathing opportunities, warmer temperatures year-round.

5. How does the breeding season differ between the UCSD population and the Mount Laguna population?

Mount Laguna population only breeds two months during the year (May – June), UCSD population breeds seven months out of the year (February – August). This means that the USCD population can have multiple clutches.

6. How has living in an urban environment impacted the UCSD Junco physical traits, behaviors, & physiology? (List 2 – 3)

Can be any of the following:
UCSD Population Juncos have/are…
Physical Traits: Less head black, shorter wings, less tail white
Behaviors: More bold, less aggressive, better parents, less extrapair mating, higher song frequency
Physiology: less corticosterone (stress), lower testosterone

7. What are common garden experiments? Why would a scientist use this type of experimental design?

An experiment that includes raising two different populations in the same environment. Scientists use this experimental design to test whether traits are the result of genetic make up or environmental influence (to answer the nature vs nurture question).

Critical Thinking Questions

8. How do you think urban noise impacts a male juncos ability to defend a territory or attract mates?

9. What predictions would you make with regard to the evolution of song in the UCSD population?

10. What is the significance of knowing how long ago the UCSD population stopped migrating for the breeding season?

11. Given enough time, what do you predict will happen with the UCSD population's ability to interbreed with other Dark-eyed Junco populations? Make a prediction as to what will happen to the UCSD population with regard to species status.

What we can learn from the *Junco*

Outro

Run Time - 3:15

Recapping themes from the prior modules and previewing the junco research of the future, this closing segment reinforces the broad range of important scientific findings involving the Junco. Featuring sound bites from more than a dozen diverse scientists who study the Junco, the importance of emerging genetic and genomic research tools are emphasized. Viewers are reminded to consider all that can be learned from a little backyard bird.

This final segment shows students that science is a collaborative effort. In order to gain a full understanding of biological mechanisms and species many scientists follow their interests to ask questions that fit together in a puzzle-like fashion. Scientific meetings are part of the communication process that scientists undergo so that they can understand what has been answered and new questions that have arisen. Students will get a glimpse at future topics that may be addressed with the Junco.

Keywords:

adaptation; animal behavior; behavior; behavioral ecology; biology; bird; birds; Dark-eyed Junco; climate change; DNA; divergence; diversity; diversification; documentary; ecology; evolution; evolutionary biology; gene; gene sequence; genetics; genome; genomic; genomics; Indiana University; intro; junco; *Junco*; Ketterson, Ellen; mate choice; McCormack, John; Mila, Borja; Mountain Lake; natural selection; nature; ornithology; outro; phenotype; phylogeny; phylogenetics; physiology; rapid evolution; research; Rowan, William; science; scientific method; sequencing; sexual selection; social behavior; snowbird; songbird; speciation; species; species concepts; testosterone; trailer; University of California-San Diego; UCSD; Yellow-eyed Junco; urbanization

National Academies Science Standards
For a copy of these standards see:
http://www.nap.edu/openbook.php?record_id=4962

Page 108, table 6.7; Pages 111 – 119, science as a human endeavor, nature of scientific knowledge, Page 200 – science as a human endeavor; Page 201 – nature of scientific knowledge.

AAAS – Benchmarks in Science
Standards website: http://www.project2061.org/publications/bsl/online/index.php
The Nature of Science: 1A/H3a
The Scientific Enterprise: 1C/H12

What we can learn from the *Junco*?

Name: _____

Directions: Watch the video clip "What can we learn from the Junco?" and answer the questions below in the space provided.

1. Where did scientists meet in 2012 to discuss what questions have been answered and what questions should be answered in the future?

Indiana University

2. What are some topics in biology that we could learn about from studying the junco?

Some answers might include: speciation, adaptation to urban landscapes, sex, brain, mate choice, hormones, nature, gene expression, communication, gonads, maternal/paternal care (among others)….

3. What topics interest you? Why?