Orangutan Behavior - Adaptations to Solitary Arboreal Life in a Rain Forest - The Gist

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Title: Looking at orangutan behavior at an organismal and the species level - How do their behaviors help them survive and pass on their genes?

Time: 60 minutes

Application: Inquiry, Conservation, Animal Behavior Course

Target Audience: Science teachers and informal science educators

Misconceptions Addressed: **"**Evolution means that life changed by chance."

Science Standards:

AAAS Benchmarks: Chapter 5 - Evolution of Life - Understanding the diversity and relatedness of species.

Grades 3-5 - 5F/E1 - Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.

Grades 6-8 - 5F/M2a - Individual organisms with certain traits are more likely than others to survive and have offspring.

Grades 9-12 -

- Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species; some of these characteristics give individuals an advantage over others in surviving and reproducing; and the advantaged offspring, in turn, are more likely than others to survive and reproduce. As a result, the proportion of individuals that have advantageous characteristics will increase. 5F/H3*

- Heritable characteristics can be observed at molecular and whole-organism levels—in structure, chemistry, or behavior. 5F/H4a

- Heritable characteristics influence how likely an organism is to survive and reproduce. 5F/H4b

National Science Education Standards:

- Chapter 3 - Teaching Standard A - Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.

- Teaching Standard B - Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

- Professional Development Standard A - Involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding.

- Chapter 6 - Grades 9-12 - Behavior of Organisms and Biological Evolution

Prior Knowledge: An introduction to natural selection and evolution should be conducted prior to this activity. Background material on the natural history and ethology should be given to the adult students in preparation for the 6o minute plug in.

What Students will Learn: The students will learn basic natural history information about orangutans, how to conduct basic behavioral research, how orangutans are adapted to live in their environment of the rain forest canopy, how orangutan individuals demonstrate different behaviors or behaviors at different frequencies. The students will also understand the definitions of ethogram, kiss-squeak, genital rub, brachiate, long call, population, organism, canopy, adaptation, endangered, evolution.

How This Applies to Evolution: This plug in applies to evolution in the form of adaptation in the orangutan.

Instructions:

The adult students will conduct this activity, keeping in mind how they could use it with their students.

1. In preparation for the behavioral study, the teacher should lead a discussion about the natural history, the habitat and the behavior of orangutans. The students should understand that they will be observing the orangutans and focusing on behaviors that may optimize the animal's chance of passing on its genes. They should know that they will discuss how the behaviors in captivity may differ in a zoo than in the forests, and that they will focus on natural selection in wild populations. In the zoo the students will look at the behaviors of one organism, but then they will discuss the behaviors at the population level.

2. The group will break into groups of two and spend seven minutes observing and recording the animal's behavior. One of the pair will time, while the other records behavior.
3. The pairs will then combine their data with at least two other pair's, highlighting similarities and differences among individual orangutans, and summarizing the results.
4. The entire class will then discuss how the observed behaviors would help or hurt the orangutans to survive in their natural environment and to successfully pass on their genes.

5. The teacher will then ask the members of the group to discuss what questions they might ask and studies they would be interested in conducting if they were able to travel to Borneo or Sumatra to study orangutans in the wild.

6. A follow up activity is to discuss the conservation of the orangutan in the wild, and what actions people can take to help them in the wild.

Keywords: ethogram, kiss-squeak, genital rub, brachiate, long call, population, organism, canopy, adaptation, endangered, evolution, natural selection

Specific Concepts: Adaptations, survival and reproduction strategies, natural selection

References:

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Galdikas, Birute and Leslie Smith, (11/7/2009). *Orangutan Natural History and Socioecology*. Retrieved November 2, 2010 from

Orangutan Foundation National Website: http://www.orangutan.org/archives/568

Maple, Terry L. (1980). *Orangutan Behavior*. Van Nostrand Reinhold primate behavior and development series.

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Teacher Materials

Detailed instructions:

1. The day before the EPI is conducted in class, distribute the attached instructions and materials (Appendices A, B, C, D).

2. In a room adjacent to the orangutan exhibit, conduct an open-ended discussion of the basic concepts of the written materials including natural selection, adaptations and background on the orangutan's habits and conservation:

- generally vegetarians (omnivore)
- tree dweller
- communicates sometimes by long call and kiss squeaking, physical touching and other ways
- shy, solitary animal
- lives on Islands of Borneo and Sumatra
- Sleeps in nests of branches placed in tree
- Endangered due to habitat destruction

2. Review directions on how to record orangutan's behavior using a behavioral check list. The AIM ethogram (Appendix C) is just to be used as a reference to give an idea of what a complete ethogram looks like. The ethogram to be used in the activity (Appendix E) is a much simpler lumping of detailed behaviors. This checklist is one that is used by students studying orangutans at Cleveland Metroparks Zoo.

3. Assign student pairs to different individuals to be sure that each animal is observed. The number of individuals on exhibit will vary, so the pairs may just choose whichever animal interests them the most, and should be reminded to write the individual's name on the top of the checklist. Distribute one checklist, one pencil and one stop watch to each pair, and direct them to have one person time, and the other place a check next to any behaviors they observe at the time they are directed to make the observation.

4. Have students record the behaviors of their assigned orangutan once every 30 seconds for 7 minutes. Any interesting observations or questions should be recorded at the bottom of the sheet of paper to discuss later.

5. The pairs should then be directed to tally the number of times each behavior was seen in the 7 minute period.

6. If there are enough students conducting the observations (20 or more), group them for discussion by the individual they studied. If fewer, ask the pairs to join at least one or two other pairs for discussion.

7. Have the groups combine their data . If they studied different animals, they will be looking at the behavior now from a species level. Establish the low number and the high number for each behavior observed.

8. Gather back into one group and review :

- any behaviors seen from the ethogram of orangutans in the forest (Appendix C)
- similarities and differences in different orangutans' behaviors in the exhibit
- how the behaviors they saw in the exhibit might help or hurt the animals' chances of survival in the rain forest, and in passing on their genes to future generations
- what questions they might want to investigate if they had an opportunity to study orangutans in the rain forests of Borneo

Student Materials

Appendix A

Instructions to Adult Students the day before the EPI Activity

Attached are three documents I'm sending you in preparation for tomorrow's exercise.

Please read through the orangutan background material written by Birute Galdikas before we meet. Also take a quick look at the ethogram (description of behaviors) and the attachment on evolution (adaptation and evolution sections). It will help tomorrow if you have a general familiarity of what orangutans do.

We will spend a little time using an abbreviated ethogram to see what kinds of behaviors our orangutans demonstrate in the exhibit when they are let out in the morning, then we will discuss what we observed in relation to the orangutan's evolution and survival in the wild.

Thanks for your time.

http://www.orangutan.org/archives/568

http://www.aim.uzh.ch/orangutannetwork/CultureList.html

Appendix B

ONE

Adaptation, Evolution, and Systematics

ORDER PRIMATES

The subject of this book is the order Primates, the mammalian order that includes not only us humans but also a wide array of lemurs, lorises, galagos, tarsiers, monkeys, and apes. It also includes many extinct animals that are known to us only through fossilized remains and lack familiar names. Primates come in a variety of sizes and shapes, and this variety is matched by the diversity of behaviors primates have evolved to survive in equally various environments. This diversity in structure and behavior—and its evolution—is the theme of this book. Before considering this diversity, we review a few principles of evolutionary biology and discuss the mechanisms through which this array of creatures has come about. We also provide a brief review of biological classification and methods of reconstructing phylogeny.

Adaptation

Adaptation is a concept central to our understanding of evolution, but the term has proved very difficult to define in a simple phrase. One of the most succinct definitions has been offered by Vermeij (1978, p. 3): "An *adaptation* is a characteristic that allows an organism to live and reproduce in an environment where it probably could not otherwise exist." In the following chapters, we examine extant (living) and extinct (fossil) primates as a series of **adaptive radiations**—groups of closely related organisms that have evolved morphological and behavioral features enabling them to exploit different ecological niches. Adaptive radiations are central to our understanding of evolutionary processes. The adaptive radiation of finches on the Galapagos Islands of Ecuador played an important role in guiding Darwin's views on the origin of species.

"Adaptation" also refers to the process whereby organisms obtain their adaptive characteristics. The primary mechanism of adaptation is **natural selection**—the differential survival and reproductive success of individuals with different heritable characteristics. As Darwin argued, and subsequent generations of scientists have corroborated, natural selection ensures that any heritable features, either anatomical or behavioral, that increase the fitness of an individual relative to other individuals will be passed on to succeeding generations. In considering the evolution of behavioral traits in the following chapters, it is important to remember that natural selection acts primarily through differential reproductive success of individuals within a population. Through this differential reproductive success of different genotypes, the genetic composition of a population can change from generation to generation.

Evolution

Evolution is modification by descent, or genetic change in a population through time. Although biologists consider most evolution to be the result of natural selection, there are other, "non-Darwinian," mechanisms that can and do lead to genetic change within a population. **Genetic drift** is change in the genetic composition of a population from generation to generation due to chance sampling events independent of selection. **Founder effect** is a more extreme change in the genetic makeup of a population that occurs when a new population is established by only a few individuals. This new population may have a very different genetic composition than that found in the larger ancestral population. Thus the chance characteristics of a founder population can have dramatic effects on the subsequent evolution and evolutionary diversity of a group of organisms.

Evolutionary change within a population can ultimately lead to **speciation**—the appearance of a new species. Although biologists agree that the origin of new species is the result of evolution, there is considerable debate concerning the rate at which evolutionary change leading to formation of new species takes place and the actual mechanisms of species formation. According to the **phyletic gradualism** model, most evolutionary change takes place gradually. In contrast, the **punctuated equilibrium** model theorizes that populations are normally genetically stable, and that evolutionary change takes place primarily in abrupt genetic shifts too rapid to be preserved in the fossil record. We return to evaluate these theories in later chapters.

The origin of one species from another can take place in two ways. The change of a single species into another daughter species is called **anagenesis**; division of one species (or population) into two or more daughter species is called **cladogenesis**. Cladogenesis obviously has a more important function in the development of adaptive radiations. A reconstruction of the branching events in the evolution of a group of animals is called a **cladogram**.

Phylogeny

Because this book deals with the adaptive radiations of primates, we are interested in reconstructing the evolutionary branching sequence, or **phylogeny**, of various primate groups to see how they came to be the way they are. Although some of us can trace our own genealogies (or those of our pets) through several generations, tracing the genealogical relationships among all primates is a much more daunting undertaking. The evolutionary radiation of primates has taken place over geological time and has involved millions of generations, probably thousands of species, and billions of individuals. Moreover, the records available for reconstructing primate phylogeny are meager, consisting of individuals of about two hundred living species and occasional bony remains of several hundred extinct species drawn from various parts of the world at various times during the past 65 million years.

Morphology

The methods we use to reconstruct phylogeny are primarily based on identifying

Appendix C

Orangutan Ethogram

Retrieved October 30, 2010 from The University of Zurich Web site http://www.aim.uzh.ch/orangutannetwork/CultureList.html

BEHAVIOR	DEFINITION
NEST HABITS	
Pillow, 'bantal'	a pile of twigs or big leaves at one side of the nest on which the focal puts its head when lying down
Artistic pillows	a row of twigs, all of similar size, all radially-oriented along the nest perimeter with the forked or leafy end out, lining the nest
Blanket (loose nest cover), 'selimut'	a loose cover made from branches or leaves covering (only) the body (not the head)
Lining, 'alas'	a layer made on the nest from leaves or twigs on top of which the focal lies down
Roof (fixed roof over nest), 'atap'	a construction made from branches or twigs hanging together on top of the nest (mostly protection against rain)

Sun cover	a cover built over a nest when exposed to bright sunshine (rather than rain)
Bunk nests	a second nest, built a short distance above the nest used for resting as a rain-shelter
Hide/shelter under nest	build a nest but rather than resting in it the individual moves under it to seek shelter during rain
Leaf bundle while sleeping ("leaf doll")	gathering a bundle of leaves and taking them into their night nests, presumably to hold while sleeping
Twig biting	systematically passing ends of twigs used for lining of nest past the mouth (sometimes including actual bite) during last part of nest building
Carry leaves to nest	pick and carry leaves to nest site from other tree (e.g. Tarantang, Campnosperma sp.) before start of nest building. These leaves can be used for lining, pillow, roof etc.
Nesting in multiple trees	building a nest by tying several smaller trees together
Raspberry - sound	spluttering sounds (made by expelling air through relaxed, pouted lips) associated with nest building. Nest raspberries may be made before or after completion of the nest.
Nest smack, 'nyeletok'	smacking/clicking sounds while making a nest
Bridge nest	building a nest connecting 2 trees on opposite banks of a stream. Rather than resting in this nest the orangutan uses it to cross the river and continues moving on the other side
Play nests	building a day nest (mostly by immatures), in which

	individuals do not rest, but only play. Building is done in the presence of play partner.
Branch-cushion	Covering big branch with a few leaves or leafed branches, then rest on this, no intertwining of bent branches as in a nest.

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MOVING HABITS

Severed vine swing	Biting through a vine (so that it hangs loose on one end), to swing Tarzan-like to across a gap.
Liana tree release bite	Biting through a vine to release a tree to sway to reach adjacent tree.
Treetop break swing	Break top of tree to use as a swing to reach another (usually smaller) tree.
Branch-hook	using a detached branch to pull branch of adjacent tree within reach
Wading through water	walking, often bipedally, through standing water

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SOCIAL BEHAVIORS

Hiding behind branch	using a detached branch as a screen to hide from predators or humans

Branch dragging display (on ground)	dragging a broken branch (as the individual moves across the forest floor), in a display similar to the agonistic display of bonobos
Missiles	throwing or aimed dropping of branches, large fruits or other objects toward terrestrial predators (or humans), apparently to drive them away
Snag crashing	aimed pushing of dead standing trees as a display to conspecifics, humans or predators
Snag riding	push over a dead tree (snag), then hold on to the snag and ride down as it falls, grabbing onto nearby vegetation to stop their own fall before the snag crashes to the ground
Sneaky nest approach	building a series of ever-closing nests, not using the nests for resting, but instead moving in closer and building another to cautiously approach another, higher-ranking conspecific
Safe nest	Using a nest as social refuge by female when harassed by male
Coercive hand-holding	male holding hand/wrist or foot/ankle of female for prolonged periods during consort (often in presence of other male)
Copulation on nest	Cooperative copulation on nest of the male
Genito-genital rub (females)	pairs of female orangutans rubbing their genitals together(similar to the behaviour commonly reported for female bonobos)

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TOOL USE

Tree-hole tool-use	using (twig) tools to poke into tree holes to obtain social insects or their products
Seed extraction tool-use	using (twig)tool to extract seeds from the protected fruits of Neesia sp., which are embedded in irritating hairs, hidden within the very tough outer casing of the fruit and exposed only through slowly opening fissures in the fruit`s valves as the fruit dehisces
Stick as chisel	using a stick to break open a termite nest in a log on the ground
Branch as swatter	using detached leafy branches to ward off a swarm of insects (bees/wasps) attacking subject (who is raiding their nest)
Leaf gloves	using leaf gloves to handle spiny fruits (e.g. durian) or as seat cushions in trees with spiny branches (e.g. Erythrina
Leaf body scrub	using a leaf or leaves to wipe off/clean water or dirt from body surface
Leaf napkin	using handful of leaves to wipe latex off chin after eating some fruits
Leaf "umbrellas"	using large leaves or leafy branches to cover the head most often during rain or, play. Note if in other context.
Scratch (with) stick	using a tool for auto-grooming (for example: using a detached stick to scratch body parts)
Autoerotic tool	using tool (generally a detached stick) to stimulate genitals,

	or masturbate (female and male)

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FEEDING

Drink water with hand (finger -drip)	drink water with hand either from ground or from tree-hole (hand-dip-drip method)
Drink water with cupped-hand	drink water from cupped hand with which individual scoops water from ground or tree-hole
Branch scoop	use a leafy branch to extract water from deep tree-holes.
Drink sponging	use crumpled leaves to absorb water from a tree hole, then drink the water from the leaves
Drink from leaf scoop	drink water using leaf as vessel (drinking straight from vessel): 'leaf-dipping
Drink from leaves	drink water dripping from a bundle of wet leaves held above the mouth 'leaf drip method'
Drink from pitcher plant	drink from pitcher plant like a cup
Pitcher plant-bite	biting open a pitcher plant from the bottom to drink the fluid
Wash food	wash food: dipping food underwater before eating it
Leaf stripping with hand	obtaining foliage by drawing a segment of vine, liana or branch rapidly through a partially closed hand, to gather a handful of leaves before consumption
Leaf stripping with	obtaining foliage by drawing a segment of vine, liana or

mouth	branch rapidly with the mouth, to gather a bunch of leaves before consumption
Dead twig sucking	breaking hollow (dead) twigs to suck the ants from inside
Bouquet feeding	Using lips to pick ants from fistful of dry, or fresh, or rotting leaves (Certain genera of ants make their nests in leaves (e.g. Oecophyllus sp).
Nest destruction	rummaging through old orangutan nests for insects, taking the nest apart while doing so
Slow Loris eating	capturing and eating slow Loris (*Nycticebus coucang*) hiding in dense vegetation

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OTHER BEHAVIORS

Symmetric scratch	exaggerated, long, slow, symmetrical scratching movements with both arms at same time, in something that resembles calisthenics or t`ai chi.
Fur sopping	Lathering of fruit pulp or seeds on fur of arms (various plant spp)
Autoplay with water	splashing water with hands/feet without obvious feeding/drinking purpose, scooping water over body or even dipping/immersing (part of) body under water ('bathing')

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VOCALIZATIONS

Kiss-squeak (KSQ)	a vocalization/facial expression commonly given by orangutans in contexts suggesting mild alarm or annoyance towards conspecifics or observers. Several variations may be distinguished (see below.
KSQ (unaided)	KSQ only with mouth
KSQ with leaves	wiping a fistful of crumpled leaves over the face, then dropping the leaves (in similar context to the KSQ, often accompanies the KSQs)
KSQ on (bunch of stripped) leaves (on arm)	using leaves that are held near or in front of the mouth during the KSQ (apparently to amplify the sound; Peters 2001), then allowing the leaves to fall.
KSQ with hand(s)	KSQ with a hand in front of the mouth (several variations follow)
KSQ with finger/thumb in mouth	KSQ with a finger or thumb in mouth
KSQ with (whole) hand (trumpet style)	KSQ holding the hand(s) like a trumpet in front of the mouth
KSQ with fist	KSQ with fist in front of mouth
KSQ on inside (palm) of hand	KSQ on inside (palm) of hand
KSQ on back of hand	KSQ on back of hand
KSQ on inside wrist;	KSQ on inside wrist
KSQ with mouth-wrap	KSQ with hand wrapped around mouth

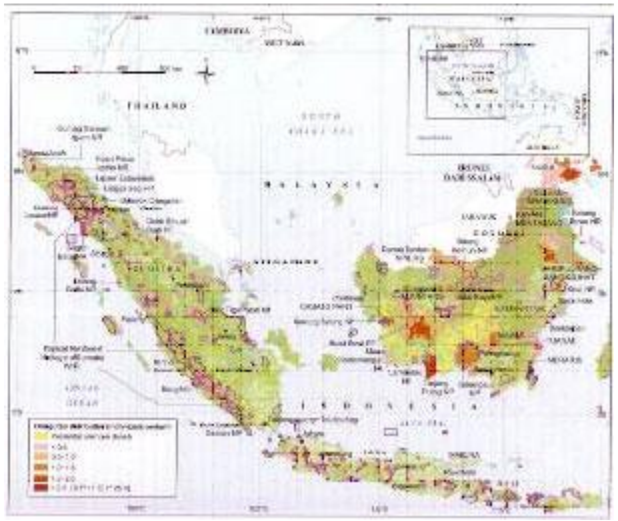
KSQ on arm	KSQ on arm
KSQ on branch	KSQ with (on tip of broken) branch
KSQ on tree trunk	KSQ on tree trunk
Throat scrape	Repetitive deep throat sound made by female towards offspring.

Appendix D

Orangutan Distribution

Orangutans are the only great ape outside of Africa and they are uniquely adapted to the tropical forests of Southeast Asia. During the Pleistocene, orangutans ranged throughout forests in Java, Sumatra, Borneo, Vietnam and southern China. As climate slowly changed over nearly 1.8 million years, the orangutan range shifted southward.

Orangutan populations have declined dramatically, perhaps by as much as 97%, in the 20th century (1) due to hunting and forest loss. Today orangutans are patchily distributed in fragmented lowland forests in Borneo and Sumatra. Tanjung Puting contains one of the largest and most concentrated populations of wild orangutans in the world.



Current Population Estimates

The most recent population estimate for *Pongo abelii* is around 7,300 individuals (2). For Bornean orangutans, numbers are between 45,000 and 69,000 individuals (3). With substantial habitat losses since 2003, when these estimates were obtained, it is likely that

Bornean orangutan populations are substantially lower (4). Galdikas estimates there are less than 40,000 Bornean orangutans in the wild.

Two Species

Currently two orangutan species are recognized: *Pongo abelii* representing the Sumatran lineage and *Pongo pygmaeus* representing the Bornean lineage. Dividing the orangutan into two species was much debated in the 1990s, but this separation of species is supported by genetic analysis and a general attitude of "taxonomic inflation" in primatology. Recently, researchers have found that these two orangutan lineages differ more than the chimpanzee and the bonobo (5).

Sumatran orangutan

Pongo abelii and *Pongo pygmaeus* have been geographically isolated for at least 10,000 years by the Java Sea and large rivers on the Sunda shelf. But genetic analysis suggests that the species diverged long before this, when large distances effectively separated Bornean and Sumatran populations.

The appearance of the Bornean and Sumatran orangutan can be quite different. Bornean orangutans tend to have dark red or orange hair compared to the lighter colored Sumatran orangutans whose hair tends towards blonde, yellow, or a lighter shade of orange. Bornean orangutans rarely display the fine, dense facial hair characteristic of their bearded Sumatran cousins. Males differ more markedly than females, with many Bornean adult males having cheek pads that curve forward rather than lie flat on the face, and larger throat pouches compared to Sumatran orangutans.

Bornean orangutan

Behaviorally, the Bornean and Sumatran orangutans show some differences, probably due to the ecological differences in their forest homes. Bornean forests are relatively fruit-poor. Since orangutans depend on large supplies of sugary, pulpy, ripe fruit, adult Bornean orangutans seem to spend more time living a semi-solitary lifestyle compared to Sumatran orangutans. This may account for the observation that tool use seems less prevalent among wild Bornean orangutans compared to their more social Sumatran cousins.

Despite some differences in morphology and behavior between *Pongo abelii* and *Pongo pygmaeus*, all orangutans share similar life histories and respond to the same major ecological and anthropogenic factors. Therefore, research conducted on both species helps scientists and conservation managers understand the "orangutan".

Life History

Like other apes, orangutans have a slow life history which makes it difficult for them to recover from severe population losses (6). The average age of first breeding for females is around 15 years with a maximum reproductive age of 45 to 50 years (7). Unique to orangutans, females care for dependent offspring for at least six years (8), and have an interbirth interval of eight years (9), the longest of any mammal. The ecological cost of associating with multiple offspring best explains the long interbirth period (6).

Males and Females

Orangutans are large-bodied and exhibit extreme sexual dimorphism. Subadult males are about the size of adult females. At maturity, females may weigh about 40kg. At sexual maturity, males are about twice this size, weighing more than 80kg. Some wild males may actually weigh over 120 kg while in captivity males have weighed over 200 kg. Adult males also express secondary sexual characteristics including wide cheek pads and a well-developed throat sac which enables them to make periodic vocalizations known as long calls (10,8).

A Life in the Trees

Despite their large body size, orangutans are almost exclusively canopy-dwelling. Orangutans travel through the canopy where they find most of their food (fruit, young leaves, and bark). Females are more exclusively arboreal than males and Galdikas (8) has suggested several hypotheses. There is a higher energetic cost associated with carrying infants, so females may tend to stay in the canopy rather than spend energy climbing down and back up into the trees. Infants and juveniles may also be in greater danger on the ground, where pigs can attack them. In contrast, males, which travel alone are free to exploit more resources on the ground. This may explain why males are often observed feeding on termite nests, a food which females eat much less frequently – except when pregnant. Then they tend to forage on termites in the canopy.

Social Behavior

Orangutans are semi-solitary since fruit is not abundant enough to allow orangutans to be permanently gregarious. However, they do form parties to gain social benefits when there is an abundance of fruit (6).

Some observers, e.g. Galdikas (8) have noted a degree of sociality among adult Bornean females at Tanjung Puting. In addition, most observers, such as Galdikas (11), have documented that independent immature orangutans, particularly adolescent females, are almost gregarious and social compared to adult individuals of their species.

Adult females are often accompanied by their offspring, and even after reaching maturity, young adult females are known to establish home ranges near or overlapping with their mothers (8). This dispersal pattern may be considered a variation of female philopatry (6).

In contrast, males tend to disappear from the area where they were born as they mature and observations of wild orangutans suggest males are more likely to disperse long-distances (12).

Females, juveniles and subadult males may encounter and tolerate one another when temporarily congregating in a location with abundant fruit. In contrast, adult males do not tolerate each other and space themselves using long calls (8, 10, 13).

Mating System

The orangutan mating system is called short term polygyny. This means individuals can select new mates every year. Both males and females may have multiple mates, although individuals may breed with the same mate over more than one pregnancy . Adult males and females normally mate during consortship often initiated by females (8,14). Forced copulations with females do occur, most often by subadult males (15). However, many offspring are conceived during consortship with adult males, indicating female mate selection may be an important factor in reproductive behavior.

Daytime Activity

Long-term observations of wild orangutans show that more than half their daytime activity is spent feeding. Orangutans spend another 30% of their time traveling to food resources and 15% of their time resting. Only 2% of their time is spent in other activities including mating and other social interactions. (These numbers are averaged from studies by Rodman (16), Knott (17) and Galdikas (8). However, orangutans may travel, rest, and forage in association with other individuals without overt social interaction.

Feeding behavior (8,11,12,18,19), ranging behavior (17,21) and response to disturbance (20,21) appear to be the primary factors that determine orangutan distribution within forest habitat.

The orangutan's unique natural history and socioecology underlie their limited distribution and endangered status.

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Appendix E

Ethogram/checklist of daytime behaviors of orangutans

Behaviors		0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	Total
Social	interaction between two or more animals															
Auto-groom	manipulation of one animal's own fur/skin/body															
Inactive	sedentary behavior while awake or asleep															
Locomote	moving from one area of the exhibit to another															
Feeding	consumption of food/browse															
Nest-Build	manipulation of nest-building materials to form a platform for laying or sitting; covering one's head with nest-building materials															
Active Other	any behavior not listed but performed without being sedentary															
Not Visible	animal cannot be seen during scan sampling															

Reflection

This plug in was tested with the staff and volunteers at Cleveland Metroparks Zoo. The test prepared me for using this EPI as part of the Primate Behavior class included in the Advanced Inquiry Masters Program. Input was especially needed on the timing of the activity, and the transition from the behavioral study, which I feel comfortable with, and the discussion of evolution.

Initially I had not required any background in the subject matter from the students before we conducted the activity, but as I made the final preparations to test the EPI I realized that the students would need to review the basics of natural selection and the biology of the orangutan at least the day before the activity. Just as our Masters students will have varying backgrounds when we conduct this activity, the backgrounds of the educators and volunteers who tested the activity varied from having had no biology classes to Masters degrees in biology. The handouts were given to them to review the day before. In the future I will also lead a classroom review of evolution at least a few hours before the EPI is conducted.

Originally when the EPI was designed, I had not planned on asking the students to note when they had observed a behavior that was of special interest to them. That addition was made during the testing when I had time to consider other inquiries that could be done while I was recording the behaviors. This led me to strengthen the activity by asking the group what questions they might pursue if they were able to study orangutans in the wild. This helped to reinforce the basic concepts of inquiry, and led to an additional discussion about the conservation of orangutans and actions we in the United States could take to help orangutans.

One final change made as a result of the test related to the group work focusing on the data. Originally I had planned on asking the groups to focus more on the data tabulation. However I realized early on that too much time would have been spent on the activity that really did nothing to reinforce the evolution or conservation topics. Therefore I had the groups only figure the basics – the most commonly demonstrated and the least commonly demonstrated behaviors in the zoo setting