An Analysis of Sex Ratio Management in Captive Primates

Jason Scott

Sex Allocation Theory

- Natural Selection should favor mothers that produce offspring of the sex that most increases their own fitness
  - Trivers-Willard Effect (Trivers and Willard 1973)
  - Local Resource Competition (LRC) (Clark 1978)

- In most cases a 50:50 sex ratio should be favored by natural selection

The Trivers-Willard Effect

- Females in good condition should favor sons
  - Sons should benefit from good condition of mother
- Females in lesser condition should favor female offspring
  - Less variance in reproductive success

Trivers-Willard Effect in Action

- Demonstrated in humans on the Forbes billionaire list (Cameron and Dalerum 2009)
  - Women in highest economic bracket give birth to more sons
  - Significantly different from general population

The Romney Effect?

Local Resource Competition (LRC)

- Natural selection will favor the production of the dispersing sex if the non-dispersing sex is likely to engage in competition with relatives
- Males are the dispersing sex in most primate species

Evidence for LRC

- Clark (1978) found evidence for this hypothesis in the brown greater galago
  - Exhibited a male-biased sex ratio at birth
  - Adult females antagonistic towards unrelated young females

Why is this important?

- Potentially useful for captive breeding programs
  - Could allow zookeepers to avoid the inadvertent skewing of sex ratios
  - Could allow for the intentional manipulation of sex ratios

Why is this important?

- Excess males already posing problems for zoos (Faust and Thompson 2000)
  - Propensity to form bachelor groups complicated by space restrictions
- Others Complications:
  - Unstable age structures
  - Reduction in reproductive potential

Question of Interest

- Do management practices/decisions seem to play a major role in shaping the sex ratio of captive primates?

- Expectation:
  - 50:50 sex ratio for monogamous species
  - Female-biased for polygynous species

What I did

- Collected the species holding records of every primate species in the ISIS database

- Compared the sex ratios of primate species in captivity to published birth sex ratios and to predictions of sex allocation theory

Methods

- 25 species of primates
- Collected information for each species
  - Sex ratio of species in captivity
  - Published records of sex ratio at birth
  - Dispersing Sex
  - Social System

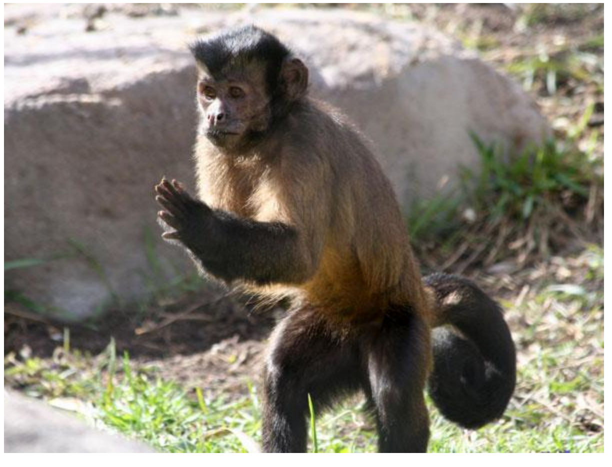
Results

- 7 species had no bias in actual sex ratio (ASR) or birth sex ratio (BSR)
- Of the 13 species with a biased BSR, 11 were male-biased and two were female-biased
- Of the 13 species with a biased sex ratio in captivity (ASR), 6 were male- biased and 7 were female-biased

Results

- 5 species had a biased birth sex ratio, but no bias in actual sex ratio in captivity

Species	Social System	Dispersing Sex	ASR Bias	BSR Bias
Brown capuchin (*Cebus apella*)	Polygynous	Male	None	Male ($P<0.01$)
Golden-headed lion tamarin (*Leontopithecus chrysomelas*)	Monogamous		None	Male ($P<0.05$)
Crab-eating macaque (*Macaca fascicularis*)	Promiscous	Male	None	Male ($P<0.05$)
Lion-tailed macaque (*Macaca silenus*)	Polygynous	Male	None	Male ($P<0.05$)
Emperor tamarin (*Saguinus imperator subgrisescens*)	Promiscous	Both	None	Male ($P<0.01$)



Results

- 5 species had a biased sex ratio in captivity, but no bias in birth sex ratio

Species	Social System	Dispersing Sex	ASR Bias	BSR Bias
Western gorilla (*Gorilla gorilla gorilla*)	Polygynous	Female	Female (P<0.05)	None
Golden lion tamarin (*Leontopithecus rosalia*)	Monogamous		Male (P<0.001)	None
Mandrill (*Mandrillus sphinx*)	Polygynous	Male	Female (P<0.001)	None
Chimpanzee (*Pan troglodytes*)	Promiscous	Female	Female (P<0.001)	None
White-faced saki (*Pithecia pithecia*)	Monogamous		Male (P<0.05)	None

Results

- 2 species had actual sex ratios that were opposite those reported for birth

Species	Social System	Dispersing Sex	ASR Bias	BSR Bias
Japanese macaque (*Macaca fuscata*)	Promiscous	Male	Female ($P<0.001$)	Male ($P<0.05$)
Common squirrel monkey (*Saimiri sciureus*)	Polygynous	Both	Female ($P<0.001$)	Male ($P<0.01$)

Results

- 6 species had matching biases in birth and actual sex ratios

Species	Social System	Dispersing Sex	ASR Bias	BSR Bias
Common marmoset (*Callithrix jacchus*)	Promiscous	Male	Male (P<0.01)	Male (P<0.01)
Ring-tailed lemur (*Lemur catta*)	Polygynous	Male	Male (P<0.001)	Male (P<0.01)
Rhesus macaque (*Macaca mulatt* a)	Promiscous	Male	Female (P<0.01)	Female (P<0.01)
Hamadryas baboon (*Papio hamadryas*)	Polygynous	Male	Female (P<0.001)	Female (P<0.01)
Cotton-top tamarin (*Saguinus oedipus*)	Monogamous		Male (P<0.05)	Male (P<0.01)
Black-and-white ruffed lemur (*Varecia variegata*)	Promiscous	Male	Male (P<0.01)	Male (P<0.01)

Discussion

- Management decisions seem to affect the sex ratios of many but not all species in captivity
- Sex ratios of some captive primate species do seem to be influenced by the birth sex ratios
- BSRs seem to provide evidence for local resource competition hypothesis

Questions?