The Case of the Sexually Arrested Orangutans

Susan B. Chaplin and **Laura J. Baumgartner**
Department of Biology
University of St. Thomas, St. Paul, MN

Part I— A Call from Anne

It was late in the work day and I was rushing around trying to get some new chimps settled in their habitat when the phone rang.

"Hi Lisa, it's Anne and I've got a favor to ask. I know you have some captive male orangutans at the National Zoo and I'm hoping you'll help me collect some growth, development, and behavior data on these animals. I've enlisted the cooperation of curators at 12 other zoos in the U.S. to help me assemble this database on juvenile male orangutan development.

"As you may know," Anne continued, "when juvenile males are housed together, some begin to develop the characteristic secondary sex characteristics at age four, resulting in the massive body size, large cheek flanges and laryngeal sac, while others stay juvenile looking but grow to nearly adult size. I think the difference in development might be due to variation in the effects of captive stress, mostly from the presence of other adult males. When we separate the arrested individuals from the rest, they complete their maturation to adulthood rather quickly."

As an Assistant Curator at the Smithsonian National Zoo in Washington D.C., I was in charge of the care and health of the primates and pandas, and thought this sounded like an interesting project.

"I think we can do that Anne. Actually, I have also noticed those developmental differences in juvenile orangutans and always wondered why they occur."

"Good, then you'll know what to look for. I need information on their housing situation, diet, medical history, growth, behavior patterns, and as they go through puberty, flange and laryngeal sac development, social interactions, and semen quality if you manage to collect that. I would also like you to collect fresh urine samples from each individual periodically. The lab at the Center for Reproduction of Endangered Species (CRES) at the San Diego Zoo will run hormone assays on the urine for me. I'll send you a spreadsheet for keeping records on each animal. You can send the urine samples and spreadsheet data to CRES for analysis. I really appreciate your help."

Questions

1. Explain the normal hormonal control of male sexual development by the hypothalamus-pituitary-gonadal axis.

2. Are there other hormones that might influence reproductive maturation? Which ones and how do they affect growth and development?
3. Make a list of hormones that might be lacking in males exhibiting arrested development of secondary sex characteristics.
4. What are the stress hormones? How do they act? Specifically, how does stress affect growth and development?
5. What sort of data might support Anne's hypothesis that arrested sexual development of juvenile orangutan males is a result of social stress?

Part II—Data Analysis

"How are your orangutans behaving Lisa?"

It was Anne calling again about her project. I told her my captive orangutans had remained healthy and active the past three years during which I had been collecting the necessary data and forwarding it for analysis to the Center for Reproduction of Endangered Species at the San Diego Zoo.

"Great. I'm sending you a report with the data summarized so far from 13 zoos and a total of 23 males. We've measured cortisol and prolactin levels in the urine and made comparisons of hormone levels in four groups of orangutans: juvenile, arrested adolescent, developing adolescent, and adults."

Below are Anne's data graphed to show means and standard errors. I'm not sure what it all means.

Figure 1. Urinary cortisol levels expressed as µg of hormone per mg of creatinine in four different groups of captive male orangutans. Asterisks indicate groups significantly different from *developing* males.

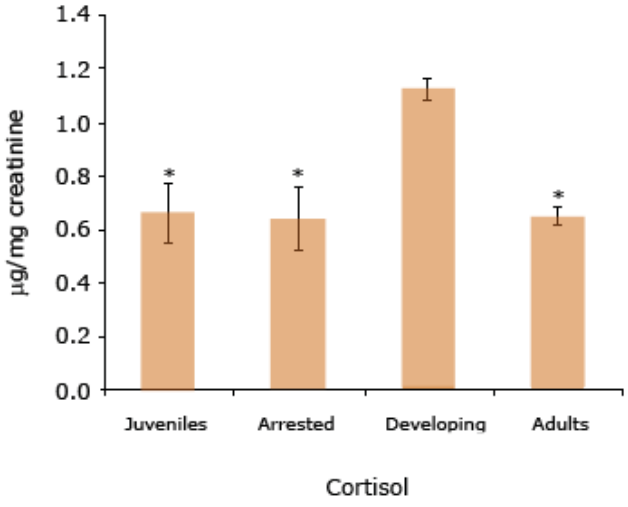
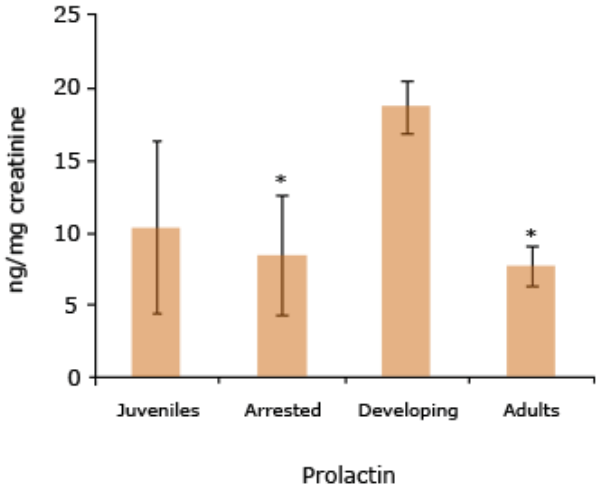


Figure 2. Urinary prolactin levels expressed as ng per mg of creatinine in four different groups of captive male orangutans. Asterisks indicate groups significantly different from *developing* males.



Data from Maggioncalda, A.M., N.M. Czekala, and R.M. Sapolsky (2002).

Questions

1. What are the significant trends in these data? What can you conclude about stress levels in arrested vs. developing males?
2. Why did researchers look at prolactin levels? What does prolactin have to do with sexual maturity and stress?
3. Why do you think stress hormones are higher in developing males than in arrested or fully mature males?
4. According to these data, is stress the explanation for arrested development?
5. What other explanations might there be for arrested sexual development in male orangutans?

Part III—More Data, and Some Answers?

As the phone rang, I knew who it was before I picked it up. Just yesterday the latest copy of the *American Journal of Primatology* had landed on my desk, and Anne's article on growth hormone levels in captive male orangutans had caught my eye.

"Lisa, I've finished the study of arrested development in juvenile orangutans and am sending you some of the additional data we've collected. It was quite a puzzle to put together. We ended up analyzing almost every pituitary and gonadal hormone to understand the complete picture of development. I think we understand the basis for arrested development, but it has a subtle twist that no one recognized until they observed sexual activity in the arrested individuals."

"Give me the short version Anne. How does it work," I prodded her.

"OK, here it is in a nutshell. *Growth hormone* levels of developing males are three times higher than in juveniles, arrested males, and full adults, who were all similar to one another. Developing males also had far higher levels of *testosterone* and *LH* (luteinzing hormone) than arrested males, as expected, BUT the levels of these hormones in arrested males were similar to mature adults. AND arrested males had higher levels of *FSH* (follicle stimulating hormone), comparable to that in developing males and mature adults. Finally, and most surprisingly, arrested males had *mature* and *functional sperm* in their testes, and the testes were the same size as developing males. Futhermore, a new study on sexual activity of adolescent males in the wild has shown that these arrested males are in fact reproductively active, will force copulations with females when the dominant territorial male is absent, and sire a significant proportion of the infants."

"So, apparently arrested males are neither stressed nor reproductively suppressed. What is going on? And why?" I wondered aloud.

Questions

1. Based on the additional data provided by Anne's research, explain how males that appear physically arrested in development might have mature, functional sperm. What is the significance of their hormone profile (growth hormone, testosterone, LH, FSH, prolactin)?
2. The seemingly arrested development of some adolescent males constitutes an alternative reproductive strategy. How do you think such a strategy might have evolved—in a way that makes sense for males to remain juvenile looking, but reproductively capable?
3. How do the two reproductive strategies fit with the stress hormone results?