



Sexy Smells - A case study using preen oil composition of the Dark Eyed Junco



A green gland where birds produce preen oil. Figure 2 Green oil gland in Dark-eyed Junco <https://beacon-center.org/blog/2011/12/26/beacon-researchers-at-work-deciphering-avian-aromas/>

Sarah Prescott (University of New Hampshire) and Melissa Haswell (Davenport University)



Abstract

This case study invites students to explore the biochemistry and physiology of pheromones using authentic data. The case is based off of research published by Dr. Danielle Whittaker et. al. and presents data on the composition of preen oil of the dark eyed junco. Using this data as a basis for the case, several modules were written that would be applicable to a variety of biology courses. The case was first tested in a one semester General Biochemistry course, as an introduction to Genomics and Bioinformatics. Student feedback was positive and students were excited to be able to explore this new topic using hands on investigation. Also to be included in this case are modules that will be tested in an Anatomy and Physiology course. The case is planned to be submitted to the SUNY Case Study Library later this year.

Objectives

- Multiple settings**
 - Institutional – piloted at public and private university settings
 - Year – high school through undergraduate
 - Courses – General Biology, Biochemistry, Anatomy and Physiology
- Modular** - Flexibility in combining several modules to suit curricular needs and learning objectives
- Utilize Authentic Data** - In conjunction with workshop goals of making meaning through modeling
- Introduce Bioinformatic tools**- Utilize open online tools to analyze data
- Model physiology of olfaction and neuronal function**

Pilot – General Biochemistry course

- Format**
 - Final lab activity
 - 3 hours to complete – most done in an hour
 - Worked in pairs
- Prior student knowledge/experience**
 - Case novices (majority had done 0-3 cases in past)
 - Genomics novices (<5 had conducted a BLAST search prior)
 - No prior knowledge of pheromones, steroid biochemistry, or dark eyed junco
- Instruction/Evaluation**
 - Encouraged to discuss with partner as they went
 - Case is inquiry driven, designed for you to explore and discover knowledge as you go
 - Submitted completed assignment for credit
- Assessment**
 - Instructor observations
 - Student online survey – completed before leaving class, anonymous
 - UNH IRB #: 6872 Study: Analysis of the Effectiveness of Online Pedagogy

Case Activity (selected)

Introduction

...Historically, scientists thought that most bird species had fewer olfactory neurons, which means that their sense of smell is reduced. Therefore, it was assumed that chemical communication in birds, such as the use of pheromones for mate selection or species recognition, was essentially nonexistent. However, new research conducted by Dr. Danielle Whittaker ... indicate that birds do indeed have a sense of smell. Also, chemical compounds found in the preen oil of various passerine bird species, is used for assessing potential mates and has been linked to reproductive success. (1)

Pheromones and Steroid Biochemistry

(using Figure 1 – all activity questions indicated in Purple italics)
What component is in the most abundant in female juncos? In male juncos?

What component is in the highest proportion when looking at the preen oil composition in female juncos? In male juncos?

Genomics and Bioinformatics Exploration

...Compounds in preen oil have been linked to mate selection and reproductive success. Additional research done by Dr. Rosvall's group have investigated hormones in birds from a biochemical and genomics perspective (2). Several of the species they investigated are known to have diverged over the last 10-15,000 years with respect to several testosterone-mediated traits, including aggression, ornamentation, and body size. Their work looked at gene expression along the steroid biosynthetic pathway

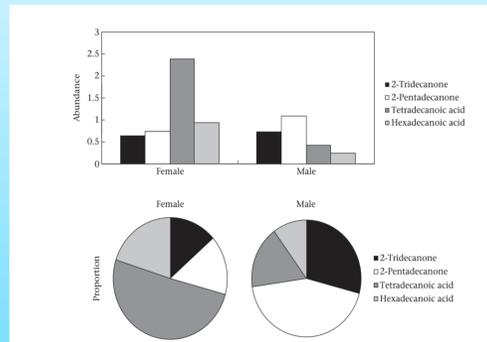


Figure 1. Abundance and Proportion of chemical compounds in preen oil (1).

Beginning at cholesterol, describe one of the two possible pathways by which testosterone is synthesized using this figure (Figure 2) and information in the caption. Include in your explanation the roles of each component in the pathway.

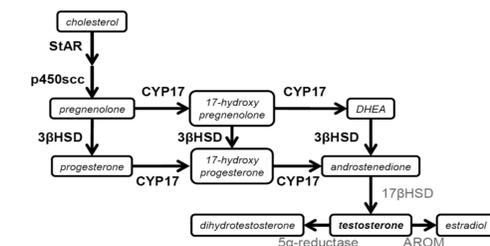


Figure 2. A simplified overview of testosterone synthesis. (2)

Genomics Exploration – selected screenshots shown at right (Figure 3). Students led through several steps to search for a sequence, BLAST this query, and analyze results using available tools within NCBI BLAST tool.

List at least 5 different organisms you see that have similar sequences to that of the cytochrome p450 sequence from the zebra finch you used. Research what the common names for these species are and include that in your list.

What types of organisms (birds, fish, insects, mammals, etc.) did you see in these returns? Do you see any that surprised you?

In this alignment, which sequence is the Query and which is the Subject?

What do the numbers mean in the alignment? What do they tell you about how the two sequences align?

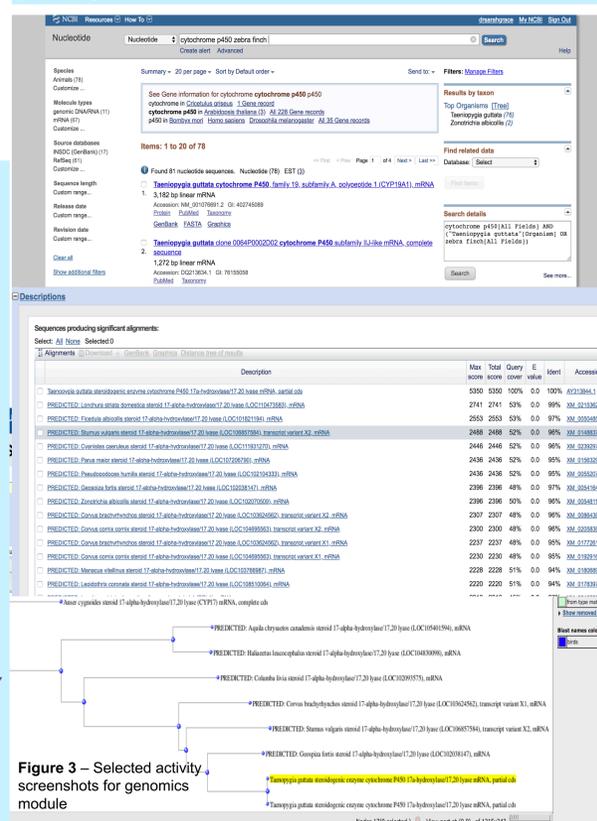
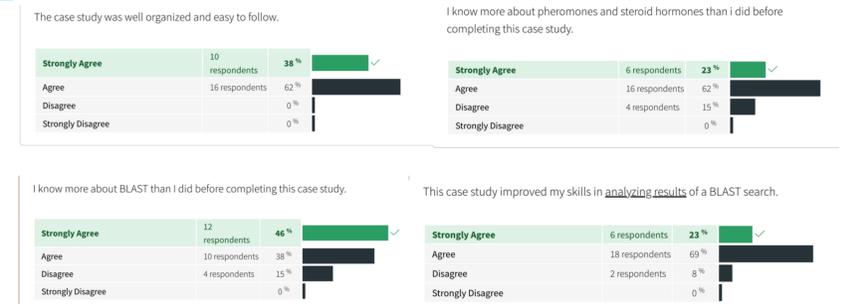


Figure 3 – Selected activity screenshots for genomics module

Survey Results



- Able to recall major concepts (pheromone, main gene family)**
- BLAST subject/query understanding**
 - "The query is the so called sequence we were looking at. The subject were of others that were being compared to the query that showed similarities among the results of the query search."
- Helpful in learning/achieved learning goals**
 - "Using the BLAST was helpful in understanding the process of analyzing data."
 - "It was helpful/useful to learn about the BLAST search as I had never heard of it prior to this. It is interesting to be able to identify and compare different birds sequences to one another."
 - "The self-guided nature of it was helpful, learning about it at your own pace and being responsible for your own results."

Discussion

On the whole, students seemed to find the case interesting, easy to follow, and that it improved their ability to conduct and analyze a BLAST search, as well as learn about bird pheromones. As these were two of the objectives, this is very promising for this case. Students seemed to be able to recall accurately several key aspects of the case which points to its success. Overall students seem to feel this was a valuable learning activity and were fully engaged.

While students mentioned needing more instruction on BLAST and the steroid biochemistry pathway, it seems that this may be due to a lack of understanding the objective of an inquiry driven case method approach and this case in particular. Such an approach would be followed up in future activities to explore and discuss further. This case was designed as a means to introduce students to this basic Bioinformatic tool and would be followed up with more discussion.

Students were confused by the steroid biosynthetic pathway, so it may benefit from a better description and editing of some of those questions. There are different levels of questions/tasks built into the activity purposely, and more guidance on the depth of information/reflection desired would be helpful in improving the case.

Future Work

Improvements to questions and some supplemental explanations will be made based on observations and survey results to the case as it was presented. Dr. Haswell is also planning on piloting several other modules of this case, as well as the introduction in her Anatomy and Physiology courses later this year.

Acknowledgements

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Works Cited

- Whittaker, D. J., et al., Bird odour predicts reproductive success, Animal Behaviour (2013), <http://dx.doi.org/10.1016/j.anbehav.2013.07.025>
- Rosvall, K.A. et al., Divergence along the gonadal steroidogenic pathway: implications for hormone-mediated phenotypic evolution, Horm Behav. 2016 August ; 84: 1–8. doi:10.1016/j.yhbeh.2016.05.015.