hhmi | BioInteractive

Winging It: Analyzing a Scientific Paper

Activity
Student Handout

INTRODUCTION

In 2017, biologists Linlin Zhang, Anyi Mazo-Vargas, and Robert Reed published the landmark scientific paper "Single master regulatory gene coordinates the evolution and development of butterfly color and iridescence." The authors used CRISPR-Cas9, a tool for gene editing, to explore how inactivating certain genes affects colors and patterns in the wings of many butterflies. They communicated their findings in a scientific journal so that others in the scientific community could know about their claims, evaluate the evidence, repeat the experiments, and use the information to design new experiments. Learning to interpret scientific research papers is a critical skill. In this activity, you will analyze a portion of this colorful scientific paper.

PROCEDURE

Open the scientific paper Zhang et al. (2017). Read the "Abstract" (the first paragraph, written in bold font if the paper is downloaded as a PDF) and the "Introduction" (the next two paragraphs).

1. The goal of the "Abstract" is to provide a brief summary of the paper. Most abstracts present the research question, the methods used, the results, and the significance of the findings. In your own words, describe the research question for this study.

2. The goal of the "Introduction" is to help readers understand why the research question is important. To do this, scientists often briefly summarize what is and is not known about the research question, as well as what they did to address the question. They may also describe the structure of the rest of the paper.
   a. What argument do the authors make for why their research is important?

   b. What do the authors say is known and not known about the genetics of butterfly wing patterns?

   c. How do the authors prepare readers for reading the rest of the paper? Consider the entire "Introduction" in your response.

3. You will now make a concept map of the information in the "Introduction." A concept map is a diagram that shows the relationships among different concepts.

   Create your concept map using the following terms as your concepts. Connect related terms with a line and label each line with a brief phrase describing the relationship between the terms.

Cas9-mediated targeted deletion	wing conjugation scales	wing pattern development
knockout studies	red ommochrome color pattern	*optix*
blue structural iridescence	adaptive hotspot	adaptive geographic variation

Read the article “Scientists Can Now Repaint Butterfly Wings,” which may be provided by your instructor or viewed online. This article describes the butterfly study to a more general audience.

4. Create a diagram or cartoon to illustrate the experimental design described in this article. Your illustration can be fairly general but should show how the scientists did the overall experiment.

Return to the scientific paper. Read the first three paragraphs of the “Results” and the caption for Figure 1.

5. What were the controls and experimental manipulations in this experiment? Give specific examples of each from Figure 1.

6. Annotate the copy of Figure 1 at the end of your handout by following the instructions below. Write everything in *your own words* and in a way that a general audience would understand.

   a. Add a title for the overall figure.

b. Write a simple *driving question* for each part of the figure labeled with a letter (A, B, C, etc.). In other words, what question did the scientists try to answer in each part?

c. Write a simple *summary* of what is shown by each part of the figure labeled with a letter (A, B, C, etc.). Your goal is to annotate the entire figure so that a reader could understand it without reading the caption.

7. Create a new diagram or cartoon to illustrate the experimental designs of the experiments *from Figure 1 only*. Make sure to include how the scientists used controls. Refer to the "Materials and Methods" section of the paper as needed to clarify the experiment. (Note you do not need to read this section in-depth. Many scientists don't either, unless they have a specific question about the procedure or want to do a similar experiment.)

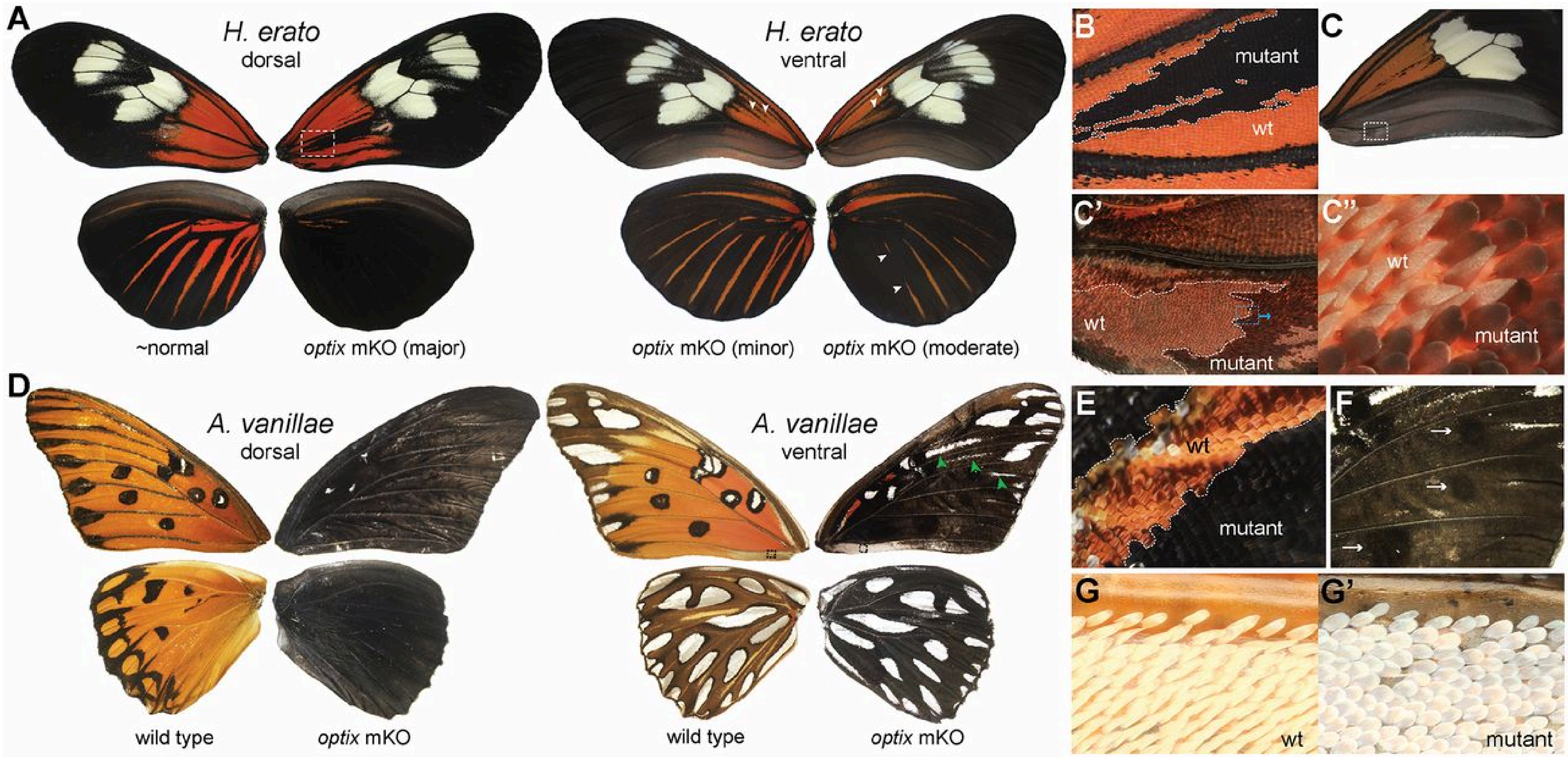

Figure 1. *optix* determines wing scale color identity and morphology in *H. erato* and *A. vanillae*. (A) *optix* mosaic knockouts in *H. erato* result in conversion of red ommochrome color patterns to black melanin. The comparisons shown are left-right asymmetrical knockout effects from single individual injected butterflies. (B) Detail of mutant clone highlighted in the mutant in A showing red replaced by black in a proximal red "dennis" pattern of the dorsal forewing. (C'–C") *optix* knockout mosaics showing transformation of pointed wing conjugation scales to normal wing scales. Each panel in the series shows successive detail. (D) *optix* replaces orange and brown ommochromes in *A. vanillae* with melanins, resulting in a black and silver butterfly. Arrows highlight presumptive clone boundaries discussed in the text. (E) Detail of a knockout clone boundary highlighting the switch between red and black pigmentation in the ventral forewing from D. (F) Ventral view of black spots in *optix* knockout mutant showing a phenotype similar to WT. (G and G') Wing conjugation scales in WT (G) and *optix* knockout mutant (G') demonstrating a role for *optix* in determining *A. vanillae* scale morphology. *Source*: Zhang et al. (2017).