Cretaceous Crime Scene Teacher’s Guide

Cretaceous Crime Scene simulates the scientific process of investigating physical evidence and using logic to interpret it. Whether students have studied palaeontology or not, this program can provide a fun and challenging simulation of the scientific process. Identifying the most likely suspect in the crime should be considered secondary to the thought process students undergo as they investigate the evidence. Some collaboration can be encouraged; however, the content structure has been designed to be navigated by individuals or small groups.

How to prepare students

- Students should be made aware that scientists use physical evidence to understand the world, and that palaeontologists use multiple lines of evidence to build a picture of the past.
- Students should learn how to read a geologic timescale and know that the abbreviation MYA stands for “million years ago.”
- Students should understand that through geologic time, organisms have evolved and gone extinct, and not all organisms lived at the same time.
- Students should understand that certain fossils indicate certain types of ancient environments. For example, fossil ferns indicate a warm, moist climate, while fossil conifers indicate a cooler, drier environment.
- Students should understand that fossils found in “bonebeds” (mass graves) represent many different individual animals. Bonebeds are often formed in wet environments where bones are transported in streams and buried by mud and sand.

What to expect

- The program is designed to be navigated by individuals or small groups of students.
- The program is designed to be used only once by each student. Students may revisit the program, but they should not expect a different crime scenario.
- The program should take between thirty and fifty minutes to complete.
- The program requires students to read instructions and content.
Technical Issues

- The program will run on any web browser with recent FLASH plug-ins, or using FLASH player. Make sure the program will run on your school’s system before involving students. You can download the FLASH plug-in at http://www.macromedia.com/downloads/
- As the program contains audio, it may be desirable to have students use headphones in a computer lab setting.
- If possible, use a video-projector or large screen to play the intro to the entire group at once, before they begin.

What to tell your students right before the program

- Their task is to look for evidence that either points to a suspect or helps eliminate a suspect. They can record this information in the Crime Data Recorder chart.
- Ask them not to discuss their solution until other students have had a chance to complete their investigation.
- They must investigate all the different lines of evidence to solve the crime. Encourage them to roll over different areas of the crime lab to locate the six different investigation stations.
- Finding the most likely suspect is only part of solving the crime. Remind them to think about an explanation of what happened.

How to help students during the program

- Encourage students to read the objective for each area of investigation, and to go to the slide-out panels to the right of the screen.
- Encourage students to roll over and click on different areas for additional information.
- Encourage students to record their findings using the Crime Data Recorder.
- If needed, direct students to the hints in the Crime Data Recorder.
- If needed, have students refer to the help section or replay the introduction for additional clarification.

What to discuss after the program

- As a group, discuss the different suspects and why some of them can be logically eliminated.
- Encourage students to share their explanations of the crime. A variety of explanations are plausible and should be positively reinforced, while also discussing alternative theories that may be better supported by the evidence.
- Reinforce that this process is similar to the scientific process palaeontologists use to investigate and understand the past.
Student Evaluation

In Cretaceous Crime Scene, there are several “layers” of content and student thought-process to consider when evaluating student performance. To realize the full benefits of the learning resource, group-discussions should follow the individual investigations.

Part A: Interpreting the Evidence

Although students may investigate the six different lines of evidence in any order they choose, to complete the Arrest Warrant they will be required to prove that they have read and understood the most pertinent facts. Below are the answers to questions 1 through 6 of the arrest warrant.

1. WHERE did the crime occur? What ancient environment was represented by the rocks and fossils found in the crime scene?
   - [ ] A semi-arid desert (dry and hot)
   - [x] A swamp forest (with land and some fresh water)
   - [ ] A marine environment (salt water)

Students determine the correct environment of the crime by looking at the rocks and plant fossils found in the Palaeo-environment section. The presence of amber, ferns, and wood indicate a moist environment with abundant plant life. The presence of mudstones and sandstones suggest freshwater environments, and the lack of marine sediments indicate that the environment was not saltwater.

The time of the crime is clearly identified in the introduction and the timeline section. The crime scene was laid down approximately 70 million years ago (MYA).

2. WHEN did the crime happen? In what range of geologic time did the crime occur?
   - [ ] 79-76 Million Years Ago
   - [ ] 75-72 Million Years Ago
   - [x] 72-68 Million Years Ago
   - [ ] 67-65 Million Years Ago

Several different things may happen at this question, depending on the student’s choice. For example, if they choose sharks, they will be told that the shark did not live in the environment they had already identified in question 1. If they choose *T. rex* or *Triceratops*, they will be told they did not live during the time of the crime. If they choose any of the other suspects, they will be allowed to proceed to the next question, even though they may have chosen the wrong suspect. This question is designed this way to prevent students from using a guessing strategy.
This question is closely linked to the previous one. If the student has correctly identified both the suspect (Albertosaurus) and the weapon (Large teeth with serrations), they will be allowed to proceed. All other combinations will result in messages that read, “That weapon was not used in the crime” or “The suspect you chose did not use this weapon”.

The arrest warrant will allow students to enter anything they want in this field, but it will not allow them to proceed without entering something. Teachers will use discretion in approving appropriate responses to this section, so some degree of creativity should be allowed.

Students must choose at least one piece of evidence from this list before they are allowed to continue. As well, they are allowed to choose any combination of two or all three.

4. **HOW was the crime committed?**

   What weapon was used to commit the crime?
   - A horn
   - Large teeth with serrations
   - Large teeth without serrations
   - Small teeth with serrations
   - Small teeth without serrations
   - A tail club

5. **WHY did they do it?** Provide a possible motive for your suspect.

   the carnivore was hungry and needed to feed her babies

6. **WHAT is the evidence against your suspect?**

   - The suspect’s footprints were left at the crime scene.
   - The suspect’s teeth were found at the crime scene.
   - Markings on the bones match the size and spacing of suspect’s teeth.
Part B: Identifying the Prime Suspect

The identification of the prime suspect is guided and recorded by the student’s use of the Arrest Warrant. The Arrest Warrant is designed to require the correct interpretation of the evidence before allowing students to proceed to the next question in the sequence. Therefore, assuming students use the learning object as directed, they cannot reach the “Offer Your Own Explanation” page unless they have correctly interpreted the evidence and identified the most likely suspect.

Below is the chart from the Crime Data Recorder filled out correctly. This is provided only as a guide to the teacher, as the Crime Data Recorder chart is a tool for the students and its use should not be mandatory. Note that based on the criteria along the top of the chart, neither Dromaeosaurus nor Albertosaurus can be eliminated as suspects. Students must have matched the distance between the teeth-marks on the marked Edmontosaurus bone to the distance between the teeth found in the jaw of Albertosaurus to correctly narrow the choice down to Albertosaurus.
The chart below identifies the key pieces of evidence for each section that eliminate certain suspects or point to a prime suspect.

<table>
<thead>
<tr>
<th>Section</th>
<th>Conclusions that can be logically deduced from the evidence</th>
<th>Suspect eliminated or indicated</th>
<th>Limitations of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footprints</td>
<td>The footprint found at the crime scene is from a carnivorous dinosaur. No scale is provided; thus, it is difficult to tell the size of the dinosaur that left the print.</td>
<td>This evidence points towards <em>T. rex</em>, <em>Albertosaurus</em>, or <em>Dromaeosaurus</em>.</td>
<td>Presence of the footprint does not strongly support the guilt of any suspect. This is circumstantial evidence only.</td>
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<tr>
<td>Timeline</td>
<td>Any animal that did not live during the time of the crime can be logically eliminated as a suspect.</td>
<td><em>T. rex</em> and <em>Triceratops</em> can be eliminated as prime suspects.</td>
<td>This evidence does not say anything about the animals that did live during the time of the crime.</td>
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<tr>
<td>Weapons</td>
<td>The distance between the marks on the <em>Edmontosaurus</em> bone are about 1 cm apart and the distance between <em>Albertosaurus</em>’ teeth are also about 1 cm apart. <strong>This tooth-marked bone is a key piece of evidence.</strong> <em>Dromaeosaurus</em> is not incriminated by this evidence.</td>
<td>The correlation between the tooth-marked bone and the jaw of <em>Albertosaurus</em> provides evidence that directly links <em>Albertosaurus</em> to the crime.</td>
<td>The weapons section indicates that almost any of the suspects had sufficient weapons to enable them to kill another dinosaur.</td>
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<tr>
<td>Crime Scene</td>
<td>The fossil tree trunks, water-worn bones, and the arrangement and variety of bones imply burial in a stream or flood. The variety of fossils found at the scene indicates that there were many victims and several other types of animals present. The separate tooth and marked bone implies a scavenging situation.</td>
<td>Crocodiles and small and large carnivorous dinosaurs are implicated by the evidence at the crime scene.</td>
<td>The crime scene does little to help eliminate suspects, but does provide key evidence to understand the circumstances of the crime and to build an alternate explanation.</td>
</tr>
<tr>
<td>Motives</td>
<td>The motives section encourages students to address the question of “why” their suspect would have committed the crime.</td>
<td>Elimination or incrimination of any suspect will be unique to the thought-process of the each student.</td>
<td>This section will help students build a stronger case against their prime suspect(s).</td>
</tr>
<tr>
<td>Palaeo-environment</td>
<td>The evidence in this section clearly establishes the environment as terrestrial (with freshwater present). In light of this, it is logical to eliminate suspects who could not survive in that environment.</td>
<td>The shark is easily eliminated using this evidence, and suspicions towards <em>Champsosaurus</em> would be reduced.</td>
<td>Given a creative explanation from the student, this evidence may not eliminate any suspects.</td>
</tr>
</tbody>
</table>
Part C: Explanation of the Crime

As various explanations of the crime will arise, it is important to encourage students to think about which parts of their explanations can be supported by physical evidence, and which parts are speculative. Some pieces of evidence can be interpreted in a variety of ways, with alternate explanations having varying degrees of arguable validity. Through group discussion and debate, students may come to a new understanding of the evidence and may wish to revise their explanations. Teachers may want to encourage small groups to work together to construct better explanations, or come to some consensus as a class.

Teachers may provide the following thought questions to guide students in their interpretation or reinterpretation of the evidence. Some of these ideas are also found in the "hints" sections of the Crime Data Recorder.

1. How can you explain the death of many individuals?
2. What is the significance of the arrangement of the fossilized logs?
3. What is the significance of the eroded elements (water-worn bones)?
4. Would the hunting or scavenging activities of carnivorous animals be correctly viewed as a criminal act?
5. Is the “crime scene” definitely where the crime occurred, or have the fossils been moved?
6. Which pieces of evidence can be discounted as being “circumstantial?”

Scattered throughout Cretaceous Crime Scene is additional evidence that can help to build a more complex picture of the events that led to the death and burial of the victims. The example below provides an explanation that is well supported by the physical evidence.

“Although the physical evidence points to *Albertosaurus* as the prime suspect, we cannot jump to the conclusion that it was responsible for the deaths of the edmontosaurs. The tooth-marked bone only established that *Albertosaurus* fed upon some of the victims, but they may have already been dead. As well, the large number of victims found in the bonebed suggests that whatever did kill these dinosaurs was capable of killing a whole herd at once. Even carnivores that hunt in packs rarely kill more than one or two animals at a time.

“The fossilized wood at the crime scene is arranged in a way that suggests a "log-jam" situation. The presence of water-worn bones and mudstone would also support the idea that the animals were buried in freshwater sediments. Although we cannot say for sure that this water was involved in the death of the dinosaurs (only their burial), a local flooding event or tropical storm would explain the large number of victims found.

“If the *Edmontosaurus* herd was killed by a natural disaster and the albertosaurs were simply feeding off the dead carcasses, it would not be fair to say that a crime was committed. If this explanation is accepted as the most likely hypothesis, it would be appropriate to conclude that no “crime” was committed, and there is not a strong case against *Albertosaurus.*”
The explanation above is based on a good understanding of the interpretation of fossil evidence; this example should not be expected from the average student, nor should it be considered “the right answer”. Like the science of palaeontology itself, the presence of rival theories contributes to the overall understanding of the past and continual advancement of scientific thought.

**Evaluation of the Resource**

In an attempt to continuously improve this resource and others like it, it is hoped that teachers and students will take the time to evaluate it. When the Arrest Warrant is activated, a link will appear to the left asking the user to “Let Us Know What You Thought.” All responses to this survey will be anonymous and will be used in ongoing evaluation and improvement of this digital learning object.

Please encourage students to be fair and honest when providing feedback and take measures to discourage inappropriate responses that will interfere with the interpretation of this information.

For a list of other resources available to educators from the Royal Tyrrell Museum of Palaeontology, please go to [www.tyrrellmuseum.com](http://www.tyrrellmuseum.com).