Team Name:_____ **Score:**_____/

Team Number:_____ **Rank:**_____

California Central Valley Science Olympiad

Edison High School

Directions: This exam consists of 20 stations, each based on different aspects of the Fossils Science Olympiad event. Each Station has an overarching theme which can play to the advantage of well-reasoned teams and can be used to make well time deductions. Each station will last for 2:00 minutes.

Directions for Proctor: This exam is often taken in a room of 20 seats, stationed in a 4x5 row-major order, and listed based on what is convenient for movement and snaking backwards. For example, the first row of seats (closest to the "front" of the room where the proctors time each station) would be labeled from West to East numerically (1-5) and the station immediately behind the fifth station would be labeled as "6". In this manner, students can snake around the classroom without moving too far save having to move from station "20" to "1".

Answer Sheet: Each station is numbered on the answer sheet. Do NOT start on the first station if you are not seated at the appropriate station. You will receive no credit for answers written on the wrong station even if they are correct. If the right answer is not in the right place, it is of no use. Some stations will have labeled items. It is your job to know whether or not to write a specimen name or specimen/item label. For example, if a question provides a carcharodon tooth with a label "A" and asks for the label of a carcharodon sample, writing the animal's name or the word "tooth" would be marked as incorrect as they would be inappropriate responses. Some questions are in fact write-in and may have multiple answers as some item
s go by multiple scientific names. No extra points will be given for providing more than one correct answer.

For any questions or concerns, please email scienceolympiadedison@gmail.com!

Station 1:

Both samples are part of which…

1) Phylum:

Mollusca (+1)

---

2) Class:

Cephalopoda (+1)

For Sample [A], please provide the...

3) Order:

Nautilida (+1)

---

4) Genus:

Nautilus (+1)

For Sample [B], please provide the...

5) Subclass:

Ammonoidea/Ammonite (either is accepted) (+1)

---

6) Despite being closely related, only sample ***A (+1)*** *is still alive today.*

7) Despite being closely related, sample ***B (+1)*** *appeared first.*

8) Fill in the box below by shading or marking the…

	Stratigraphic Range for 'A'	Stratigraphic Range for 'B'	Age of Assemblage
Holocene			
Neocene			
Paleogene			
Cretaceous			
Jurassic			
Triassic			
Permian			
Carboniferous			
Devonian			

A point per column for a total of (+3)

Station 2:

1) All three samples are part of which Phylum?

Mollusca (+1)

---

2) For Sample [A] provide the…

Subclass:

Coleoidea (+1)

---

3) Order:

Belemnitida (+1)

---

4) Genus:

Belemnitella/Belemnite (either is accepted) (+1)

For Sample [B] provide the…

5) Class:

Cephalopoda (+1)

---

6) Genus:

Baculites (+1)

For Sample [C] provide the…

7) Subclass:

Nautiloidea (+1)

---

8) Genus:

Orthoceras (+1)

---

9) All three samples share what habitat?

Marine/Ocean (either is accepted) (+1)

---

10) All three samples share what mode of nutrition?

Carnivore/Predator (either is accepted) (+1)

---

11) Of the three samples, sample **B** has intricate suture patterns.

12) Sample [C] has a long narrow chamber used for mobility, what is this chamber called?

Siphuncle (+1)

Station 3:

The decay of a Plutonium-239 isotope is modeled in graph [A]. Though you are not allowed to use a calculator on this exam, the equation for the graph is provided in figure [B]. Use this information to answer the following questions:

1) What is the half-life of Plutonium-239?

24,000 years (+1)

---

*2) If there are 50 grams of **any element**, how many grams would (approximately) be left after three half-lives?*

6.25 grams (+1)

---

3) What percentage of the original Plutonium-239 isotope would be left after 48,000 years?

25% (+1)

---

4) What percentage of the original Plutonium-239 isotope would be left after 96,000 years?

6.25% (+1)

---

5) Graph [C] and figure [D] provide info regarding the radiometric decay of Carbon-14. Given this information, what is the half life of Carbon-14?

6,000 years (+2)

---

6) If there is a controlled system which starts with 800 grams of Carbon-14 and 100 grams of Plutonium-239, how many grams of Carbon and Plutonium would there be when the quantities equal one another for the first time? (Hint: It will take 24,000 years)

50 grams (+3)

Station 4:

All of these creatures are part of…

1) Phylum:

Chordata (+1)

---

2) Subphylum:

Vertebrata (+1)

---

3) All creatures within this subphylum share what common attributes (one per line)?

Alleged spinal nervous system, vertebral column, calcium bone base, similar mode of nutrition and alleged cell structure, etc. (+2) (One point each, any valid response not listed is also viable)

---

4) All creatures on this list except **C (+1)** *(letter) are part of which clade?*

Dinosauria (+1)

---

5) What clade is this creature a part of?

Synapsida (+1)

---

6) Modern descendants of this creature can be found in which class?

Mammalia (+2)

---

7) Modern descendants of the other three creatures can be found in which class?

Aves (+1)

Creature [A] is part of...

8) Order:

Ornithischia (+1)

---

9) Genus:

Stegosaurus (+1)

Creature [B] is part of...

10) Order:

Saurischia (+1)

---

11) What does creature [B]'s name mean?

Tyrant Lizard King (+2)

Creature [C] is part of...

12) Genus:

Dimetrodon (+1)

---

13) The creature from the previous question is most closely related to genus?

Lystrosaurus (+1)

Creature [D] is part of...

14) Order:

Saurischia (+1)

---

15) Creature [D] is most closely related to which genus?

Diplodocus (+1)

Station 5:

For sample [A] provide the...

1) Class:

Mammalia (+1)

---

2) Genus:

Smilodon (+1)

For sample [B] provide the…

3) Order:

Saurischia (+1)

---

4) Genus:

Allosaurus (+1)

---

5) Sample [B] had how many fingers on each "hand"?

Three (+1)

For sample [C] provide the…

6) Class:

Mammalia (+1)

---

7) Genus:

Basilosaurus (+1)

---

8) Sample **B (+1)** *is the finger of a prehistoric animal, it was adapted for the purpose of…*

Hunting/slashing through thick armor, skin, or hide/cutting and easily grabbing prey, etc. (any valid answer is accepted) (+1)

---

9) The aforementioned sample likely shares the reason for its adaptation with sample **A (+1)**, *but they had one fundamental difference. What is this difference?*

One is a tooth and the other a claw, one is more for digestion, etc. (Any similar answer is accepted) (+1)

---

10) True or **false** *(circle the appropriate response), all of these creatures, at some point in prehistory, lived during the same period.*

11) All of these creatures are state fossils. Which U.S. state does…

Sample [A] represent?

California (+1)

---

12) Sample [B] represent?

Utah (+1)

---

13) Sample [C] represent?

Alabama or Mississippi (either is accepted) (+1)

Station 6:

For sample [A] provide the…

1) Kingdom:

Plantae (+1)

---

2) Mode of preservation:

Petrification (+1)

---

*3) What is a common method for measuring the age of a **living or recently deceased** sample of this entity?*

Counting the internal rings of the tree stump (+2)

---

*4) What is a common method for measuring the age of a **fossilized** sample of this entity?*

Carbon/Radiometric dating (Either is accepted) (+1)

For sample [B] provide the…

5) Phylum:

Chordata (+1)

---

6) Superclass:

Osteichthyes (+1)

---

7) Class:

Actinopterygii (+1)

---

8) This animal is preserved in which form of sediment?

Sandstone/Arkose (Either is accepted) (+1)

---

9) Say that your paleontological group discovered this sample and knows the ages of the rock layers above and below it. Using this information, the age of the sample can be determined using…

Relative Dating (+2)

---

10) If you were able to determine the exact age of the rock the sample is in, you would be able to use what method to determine the sample's age?

Absolute Dating (+2)

---

11) On which of the following sites would this specimen most likely to be discovered (shade the appropriate box)?

☐ *Mazon Creek*

☐ *Yixian Formation*

☐ *Beecher's Trilobite Bed*

■ *Green River Formation*

(+2)

12) Sample [C] is an element that is commonly associated with a mode of mineral replacement known as…

Pyritization (+1)

---

13) There are also other elements and minerals which can partake in replacement, such as (provide two responses)...

Carbon, calcite, calcium, aragonite, silicon, quartz,

Silver, etc. (Most other mineral or metallic element answers may be appropriate, one point each for a max of two points) (+2)

Station 7:

All samples shown are part of which…

1) Phylum:

Arthropoda (+1)

---

2) Class:

Trilobita (+1)

---

3) Sample [B] is part of what genus?

Elrathia (+1)

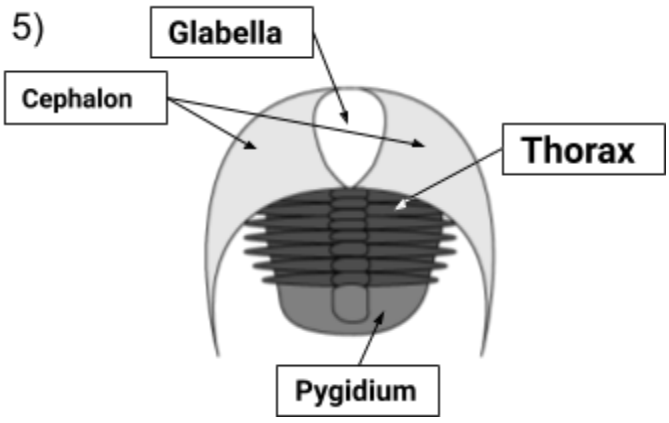
Below is a diagram of the body parts which make up one of the creatures from the class above. Identify the genus of the creature in the diagram on the line below and then label each of its body parts in the boxes provided.

4) Genus:

Cryptolithus

---

5)



(One point each for a total of four points) (+4)

6) Creatures in this class predominantly fall into what two feeder types?

Filter/Suspension Feeder (Either is accepted) (+1)

Carnivore/Predator (Either is accepted) (+1)

---

7) Which adaptation did these creatures have as evidence of these feeder types (a specific body part not indicated above)?

Gnathobases (+2)

---

8) What mode of life best suites these creatures?

Sea floor or Benthic or Infaunal/Epifaunal (any of the four is accepted) (+3)

---

9) Most creatures in this class had an eye similar to modern flies, which have thousands of lenses known as ommatidia packed together to allow for a wider range of visibility, what is this eye called?

Compound Eye (+1)

---

10) This specific class of creatures was wiped out in a massive extinction level event known as the…

Great Dying, Permian Extinction, P-Tr Extinction, P-T Boundary, etc. (+2)

---

11) This major event had multiple causes, provide one of those causes:

Small but widespread meteor impacts, volcanic activity, climate change (Any is accepted, but 'meteor impacts' or similar responses must not include a 'major collision', as this is specific to the K-T extinction later) (+2)

---

12) All three of these creatures are preserved in what rock?

Shale/Slate (Either is accepted) (+2)

Station 8:

All samples shown are part of which…

1) Phylum:

Chordata (+1)

---

2) Subphylum:

Vertebrata (+1)

---

3) Class:

Reptilia (+1)

---

4) Family:

Mosasauridae (+1)

---

5) What advantages did the bone structure seen in sample [B] provide to this creature?

Ability to swim with more agility, ability to move quickly, ability to resist more collateral injury, etc. (Any is accepted, max of one point) (+1)

---

*6) In the past decade, a large discovery has been made regarding the shape and function of what part of this creature's body? (*Hint* the incorrect version of this body part was modeled after that of modern whales.)*

Tail or dorsal fin (Either is accepted) (+2)

---

7) An index fossil exhibits what quality that makes it so useful? What can this quality be used for?

Restriction to a short prehistoric time frame, Rapidly evolving, wide distribution, easily identifiable, distinct from other creatures of the era (Any is accepted) (+1)

Relative dating of surrounding material (Or similar response) (+1)

---

8) Are these samples considered index fossils?

Yes (+1)

---

9) If a rock is found with one of these samples, about how old could the rock layer be?

Any response between 66-105 mya (+2)

---

10) What does the name of this creature mean?

Meuse River Lizard (+2)

Station 9:

1) All specimens here belong to what class?

Mammalia (+1)

---

2) Identify the genus for specimen [A].

Equus (+1)

---

3) Identify the genus for specimen [B].

Mammut/Mastodon (Either is accepted) (+1)

---

4) Identify the genus for specimen [C].

Mammuthus/Mammoth (Either is accepted) (+1)

---

5) What does the name of specimen [B] mean?

Nipple/Breast Tooth (Either is accepted) (+1)

---

6) Why are the teeth of specimen [B] have their distinct shape?

For the grounding of plants and vegetation (+1)

---

7) Specimen [A] has a common ancestor of genus…

Mesohippus (+1)

---

8) Specimen [A] once inhabited North America, but went missing and was reintroduced how?

The Columbian Exchange/ European Settlement/ trading of resources (Any is accepted) (+1)

---

9) **True (+1)** *or false (circle the appropriate response), all of these creatures, at some point in prehistory, lived during the same period.*

Station 9:

All fossils in this set belong to…

1) Class:

Chondrichthyes (+!)

---

2) Superorder:

Selachimorpha (+2)

---

3) For sample [A], provide the feeder type.

Carnivore/Predator (Either is accepted) (+1)

---

4) For sample [B], provide the genus.

Carcharodon (+1)

---

5) True or **false (+1)** *(circle the appropriate response), all genuses within the aforementioned superorder are extant.*

6) What is the largest known species within this superorder?

Carcharocles Megalodon (+1)

---

7) True or **false (+1)** *(circle the appropriate response), this species has existed simultaneously with Homo Sapiens.*

8) Describe one advantage all creatures within this class have.

Sleeker skin makes for greater mobility in water (+1)

---

9) Provide the most common mode of life among creatures in this class.

Swimmer/vagrant/nektonic (Either is accepted) (+1)

---

10) Explain why teeth are the most common and often only remains of creatures within this class.

Cartilaginous fish do not have any hard body parts outside of their jaws and teeth (Or similar point) (+2)

Station 11:

1) Both samples [A] and [B] are known as trace fossils, specifically, they are…

Coprolites (+1)

---

2) What does this mean?

They are fecal matter/droppings/dung (Or similar response) (+2)

4) What insight can these fossils grant us regarding the habits of these living creatures?

Dietary and eating habits, habitat details, environmental/climate differences from today (Any similar response is valid) (+2)

---

5) Sample [C] is part of which…

Clade:

Dinosauria (+1)

---

6) Order:

Saurischia (+1)

---

7) If samples [A] and [B] are linked to a sauropod, what can be assumed of their composition?

Primarily composed of vegetation (Or similar response) (+2)

---

8) Based on your answer to the previous question, sauropods had what in common with most Ornithischians?

Herbivorous diet, eating habits (Or similar response (+1)

---

9) Many sauropods have been found with rounded rocks in the remains, particularly within their ribcage, even when they are found away from the site of any water source. What are these rocks called?

Gastroliths (+2)

---

10) What purpose do they serve?

Grounding up food, aiding in digestion (Or similar response) (+1)

---

*11) Most mammals have what adaptation for this said purpose (*hint* think of human anatomy)?*

Gallbladder (+2) OR stomach acid, bile, or liver (+1)

Station 12:

Sample [A] is part of what…

1) Phylum:

Mollusca (+1)

---

2) Class:

Gastropoda (+1)

---

3) Genus:

Turitella (+1)

Sample [B] is part of what…

4) Phylum:

Brachiopoda (+1)

---

5) Class:

Articulata (+1)

---

6) What is a defining adaptation of all creatures within this class?

A defined symmetry or ability to articulate based on joint rooted in the pedicle valve (either is accepted, variations are valid) (+1)

---

7) Which feeder type most closely describes fossil [B]'s lifestyle?

■ *Filter feeder*

☐ *Predator/Carnivore*

☐ *Autotrophic*

☐ *Grazing/Consumer*

(+1)

8) Which most closely describes fossil [A]'s lifestyle?

☐ *Nektonic*

■ *Benthic Infaunal*

☐ *Pelagic*

☐ *Sessile*

(+1)

9) Both of these creatures are extant, but sample **A** **(+1)** *appeared during the Jurassic.*

10) Both classes survived multiple extinction level-events. Which advantages did these specific creatures and their habitats have that allowed them to survive (name one)?

Marine habitat was often less impacted, dietary habits meant no food shortage came as a result, small size made it easier to adapt or hide, general ability to adapt to climate change, etc. (+1)

---

11) **True (+1)** *or false (circle the appropriate response), sample [a] is a common fossil.*

Station 13:

1) Which letter indicates an unconformity? **F (+1)**

2) Which letter indicates a fault? **K (+1)**

3) Which law assures that layer "A" is younger than layer "B"?

Law of Superposition

---

4) Which letter indicates an intrusion? **D (+1)**

5) Which is older, the fault or the intrusion?

The fault is older (+1)

---

6) By what law?

Law of cross-cutting relationships (+1)

---

7) Despite having a distinct curvature, layers "J"," H"," I", and "G" were once level as layers "A" and "B" are. This statement is supported by what law?

Law of original horizontality (+1)

---

8) What is a naturally occurring event which could have given the aforementioned layers their curvature?

Tremor, compressed by tectonic plates, uplift from volcanic activity, etc. (Any is accepted) (+1)

---

9) By letter, label all of the layers from oldest to youngest.

Oldest **J**
I
H
G
K
F
E
C
D
B
Youngest **A**

6) What lifestyle does this practice indicate?

■ *Nomadic lifestyle*

☐ *Sedentary lifestyle*

☐ *Tribal lifestyle*

☐ *Warrior lifestyle*

7) Knowing this information, these creatures were likely:

☐ *Autotrophs*

■ *Omnivores*

☐ *Herbivores*

☐ *Filter Feeders*

Station 14:

Sample [A] was likely created by a creature in…

1) Class:

Mammalia (+1)

---

2) Genus:

Homo (+1)

---

3) What purpose was this sample likely use for?

Hunting, penetrating thick hide (Or similar) (+1)

---

4) Creatures in this genus have origins traced to which continent?

Africa (+1)

---

5) Around 30,000 years ago, animals within this genus migrated across a land bridge known as the Bering Strait hunting what animal?

Mammuthus/Wooly Mammoth (Either is accepted) (+1)

---

8) Image [B] shows the skull of species homo sapiens, which are currently alive today (taking this test)! A species within the same genus that went extinct was…

Homo Neanderthalensis (+1)

---

9) What adaptation of the skull allowed homo sapiens to survive as opposed to this other species?

A larger frontal lobe, neurological intricacy, more space for a brain in the skull (+2)

Station 15:

1) Samples [A] and [B] are evidence of what sort of natural disaster?

Meteor collision (+1)

---

2) This disaster is seen as the main cause of what major extinction?

The K-T extinction/Cretaceous extinction (Either is accepted) (+2)

---

3) Which clade went extinct in this event?

Dinosauria (+1)

---

4) Where on the planet did this disaster likely occur?

Mexico, Central America, Ring of Fire, etc. (+2)

---

5) This disaster had multiple effects, which was **NOT** *one of them?*

☐ *The obscurance of the atmosphere by ash*

☐ *The immediate destruction of multiple habitats*

☐ *The suffocation of many breathing creatures*

■ *The elimination of most small mammals*

6) True or **false (+2)** *(circle the appropriate response), this event led to the extinction of over 97% of animal species.*

7) Despite many genuses, particularly mammals, going extinct following end of the Eocene, this is not characterized as a major extinction. Explain why.

Most animals evolved from these genuses to adapt to global warming, and not a large percentage of animals went extinct (Either is accepted) (+2)

---

8) Of the five major extinctions, in which did Graptolites go extinct?

Ordovician Extinction (+1)

---

9) Coelophysis went extinct during what major extinction event?

End-Triassic Extinction (+2)

---

10) What is unique about the causes of the extinction event identified in the previous question?

The cause(s) of this extinction are mostly unknown, most are speculation at best (Or similar response) (+2)

Station 16:

1) Samples [A] is a trace fossil, specifically…

Tracks (+1)

---

2) Sample [E] depicts a sample from kingdom…

Plantae (+1)

---

3) For sample [D] provide the…

Phylum:

Anthophyta (+1)

---

4) This sample is a/an **angiosperm (+1)***, meaning that it's seeds are enclosed in an ovary.*

Image [B] shows an animal of what…

5) Phylum:

Mollusca (+1)

---

6) Class:

Gastropoda (+1)

---

7) This animal secretes a mucus that traces its path, as seen in image [C]. What is this path called?

Trail (+1)

---

8) On which of the following sites would sample [D] likely be preserved (shade the appropriate box)?

☐ *Ghost Ranch*

☐ *Yixian Formation*

☐ *LaBrea Tar Pits*

■ *Green River Formation*

Station 17:

Samples [A] is part of what…

1) Phylum:

Pinophyta (+1)

---

2) Genus:

Metasequoia (+1)

Sample [B] is part of what…

3) Phylum:

Anthophyta (+1)

---

4) Genus:

Acer (+1)

---

5) Of the two samples, sample **A (+1)** *is a gymnosperm, (6) meaning what?*

The seeds of this plant are unprotected, and they are likely in a pinecone or other open casing (+2)

---

7) Sample [A] only has a single living species today, what is this species?

Glyptostroboides/Dawn redwood (Either is accepted) (+2)

---

8) What is one place where this species can be found?

China, United States, or similar response (+1)

---

9) What is a living fossil?

Defined as a currently extant creature which bears a strong resemblance to an ancestor, so that it can provide evidence of lifestyle and anatomy (Or similar response) (+1)

---

10) Is sample [B] a living fossil, why or why not?

No, it is not a living fossil because it is to distinct From the extinct specie within its genus (+2)

---

11) Of the following, which **two** *creatures on the Science Olympiad do* **NOT** *meet the criteria of a "living fossil"?*

■ *Archaeopteryx*

☐ *Hydnoceras*

☐ *Coelacanthiformes*

■ *Tiktaalik*

(All or nothing) (+1)

12) Despite not being "living fossils" these creatures provide what important information about the fossil record?

As transitional fossils, these animals provide fine

Details about missing steps in the evolutionary

Chain of many animals, specifically between dinosauria and aves & lobe-finned fish and amphibians (Or similar response) (+2)

Station 18:

For the creature featured in the logo on the cover, please provide the…

1) Phylum:

Arthropoda (+1)

---

2) Order:

Eurypterida/Eurypterid (either is accepted) (+1)

---

3) Mode of Life:

Vagrant/Swimmer/Nektonic (either is accepted) (+2) or marine (+1)

---

4) Mode of Nutrition:

Carnivore/Predator (either is accepted) (+1)

---

5) This creature is the state fossil for the state of…

New York (+2)

---

6) **True (+1)** *or false (circle the appropriate response), animals of this phylum were the first land animals.*

7) Describe the breathing mechanism of this creature:

Layers of cartilage create a membrane which

Allows oxygen to be absorbed directly into blood (+2)

---

8) Provide the common name for creatures of this order:

Sea Scorpions (+1)

---

9) Explain why this name is misleading:

Only some of these creatures were marine and not all were classified as scorpions (+2)

Station 19:

1) All three images show creatures of what phylum?

Chordata (+1)

---

2) Specimen [A] is part of what genus?

Dunkleosteus (+1)

For specimen [B], provide the…

3) Class

Aves (+1)

---

4) Genus

Titanis (+1)

---

5) Specimen [B] goes by what common name?

Terror Bird (+1)

---

6) Specimen [B] likely used its beak for what purpose?

Tearing into prey, pecking prey to death (Anything similarly or similarly morbid is accepted) (+1)

For specimen [C], provide the…

7) Order

Ornithischia (+1)

---

8) Genus

Triceratops (+1)

---

9) Specimen [C] likely used its horns for what?

Defense from predators (Or similar response) (+1)

---

10) Order these creatures by letter from most ancient to most recent based on the geologic time scale.

Most ancient A

C

Most recent B

11) The animal in image [A] went extinct in what major extinction event?

Devonian Extinction (+1)

---

12) What was the "beak" of the animal in image [A] used for?

Tearing through other heavily-armored fish (Or similar response)

Station 20:

For sample [A] provide the…

1) Phylum:

Chordata (+1)

---

2) Class:

Reptilia (+1)

---

3) Order:

Pterosaura (+1)

For sample [B] provide the…

4) Phylum:

Chordata (+1)

---

5) Clade:

Dinosaura (+1)

---

6) Class:

Aves (+1)

---

7) Genus:

Archaeopteryx (+1)

---

8) **True (+1)** *or false, specimen [A] is often misappropriated in mass media as being in the same clade as specimen [B].*

9) Specimen [B] had a diet primarily composed of what animal?

Fish or marine animals (+1)

---

10) Said animal was likely in what class?

Osteichthyes (+1)

---

11) Sample [B] connects what two major groups of animals?

Dinosaurs and Birds (+1)

---

12) The sample in image [B] is an excerpt from books by Paul Chambers and Christian Foth. At which site would this fossil likely have been photographed?

☐ *Solnhofen Limestone*

☐ *Burgess Shale*

☐ *Beecher's Trilobite Bed*

■ *Yixian Formation*