North Carolina
Science Olympiad

FOSSILS

Information for Coaches and Contestants

Welcome! Thanks for your interest in the event. I am a past NCSO student, and hope I can share some insights from my Regional, State, and National experience with this event.

Most of the information here is presented in the first two slides, which are followed by six example stations which were used in the 2016 NCSO State competition.

Overview

- Main idea
  - Fossil identification and classification
  - Prehistoric life and geologic processes
  - Dating, index fossils, and the Geologic Time Scale
  - Paleontological discoveries and evidence for evolution
- Format
  - Rotating through stations
  - Binder (≤ 3") and Official Fossil List
  - No guidebook

The most important idea for the event is understanding how to identify and differentiate the groups on the Official Fossil List based on physical specimens and printed images. These groups are presented in taxonomic groupings, which generally reflect evolutionary relationships (groups of organisms sharing a common ancestral species). Contestants should understand how these groups are generally related, and how recently they may have shared a common ancestor (especially development of major groups, like vertebrates, terrestrial amphibians/reptiles, mammals, birds, flowering plants). Identification will be mostly visual; I would highly recommend including images of the different groups in a sort of table or on pages that are easy to reference quickly, as these will help in the many questions that ask contestants to differentiate related groups, etc.

Knowledge of prehistoric life should include an understanding of morphology and ecology, with contestants noting the major differences in anatomy, the modes of life, and the habitats of different groups. Many questions may be based on whether an organism was marine/estuarine/riparian/terrestrial etc., which tells us how the organism would have likely lived and relates to the rocks that a fossil is found in. (Most fossils are formed in or near water, where they are buried by moving sediments). Trace fossils (fossils left by the activities of an organism while it was still alive, like tracks, burrows, dung) give us further evidence of the ecological behaviors and relationships of prehistoric organisms.

An understanding of geology should extend to the modes of fossil preservation (see the official rules) and the formation of sedimentary rock layers. Younger layers occur on top of older ones, but there may be unconformities between layers, with a long gap between the time periods they represent. We can determine the age of rock layers by absolute and relative dating methods. The former typically involves the decay radioactive isotopes, the latter involves similarities in the composition of rock layers in different locations and index fossils. Index fossils are an important concept (they occur in abundance within a relatively short period, so they can be used to deduce the age of the rock layer around them).

Contestants should understand the organization of the Geologic Time Scale (era, period, epoch). I would recommend printing out a copy for your binder. A good way to get started with this event is to begin by learning about the taxonomic/evolutionary history of the major groups of life on Earth and correlating this with the Geologic Time Scale. For example, realize that the Cambrian Explosion created a huge diversity of multicellular life, which gave rise to early vertebrates; the first terrestrial tetrapods developed at the end of the Silurian and the Devonian; the major extinctions at the ends of the Permian and Cretaceous changed the dominant taxa on land and in the seas; etc.

The last aspect of the event focuses on the sources and significance of paleontological evidence. Among paleontological discoveries, the event highlights a list of specific sites around the world known as Lagerstätten. These are areas where fossils from a particular time and place are especially well-preserved and/or abundant, which provide insights into ecological communities (what organisms lived together, what organisms ate other organisms, life stages, etc.). Fossils also provide evidence for the emergence of different groups of life over time based on the development of adaptations to different environments in certain species. For example, hard-shelled eggs show a particular way in which terrestrial vertebrates evolved to be distinct from fish and amphibians.

Students will be tested on there knowledge in a round of about 20 two-minute stations (regional competitions may have fewer stations, or combine more questions/time into each). Students are allowed a binder up to three inches and hand lens. They may also bring the Official Fossil List, which I would recommend. Unlike in previous years, guidebooks are not allowed at the competition, but notes from a guidebook may be included in the binder. More on resources and how to organize your binder in the next slide.

Resources

- For Studying
  - Notes from guidebooks
  - Wikipedia, Google ☺
  - Paleobiology Database (PalebioDB.org)
  - Museum sites (Smithsonian, etc.)

- For Your Binder
  - ID images (multiple forms)
  - Geologic Time Scale (GSA or ICS)
  - Concise taxa information (environment, time range, significance, etc.)
  - Lists of fossilization modes, Lagerstätten, etc., for reference

Guidebooks can be useful for studying. I highly recommend the Smithsonian guide, though the Simon and Schuster guide is good too. That said, online resources are very helpful, and my general advice would be to try to find several sources for your information. Search engines can give good, detailed results, as well as helpful image sources. One source I would highlight is the Paleobiology Database (PaleoDB.org), which could be good for learning about specific groups, especially at the Division C level.

A more accessible set of resources (and probably a better place to start) would be the collection of sites associated with Natural History/Geology museums, and some universities. Sites associated with the Smithsonian (an others as well—use a search engine) are helpful not only for learning about specific taxa, but also for learning about the other basic and advanced topics about paleontology, including the Geologic Time Scale, modes of preservation, and specific Lagerstätten.

In general, converting your research into a useful binder is a matter of selectively rather than comprehensiveness. Get to know a lot of the background, and as you keep learning more, think about what is more significant to time periods as a whole, comparisons between groups, geological and evolutionary processes, etc. Learning about the very specific details regarding each group may be informative, but for the competition, it's the overall understanding that typically matters much more than overly specific details. By

keeping this in mind will also help your students to develop an understanding of the topic.

Students should be allowed to organize their binders however works best for them, but here I provide the format of the binders I used in competition. At the front, I had the Official Fossil List and a set of pages containing ID images with names, time ranges, and corresponding page numbers for more information in the binder. You should be able to fit all your pictures in a few pages of tables, but I would encourage you to have more than one reference image for most groups. For vertebrates in particular, you will be expected to recognize what the organism might have looked like in life, what there skeletal remains look like, and often what there skulls look like. Students should try to become familiar with several images or specimens of each group in advance.

Following this I would include pages with information for each group, with an emphasis on being concise and well-organized. For each group, use a list of the "features" pertaining to that group (the same list for each group). For example, "HYDNOCERAS – Time range: ... – Geographic distribution: ... – Natural habitat: ... – Ecology: ... – etc." If you have a full page of information on each group, you probably have more than you need for a competition. My binder had about four groups per page (single spaced 12-pt font). That said, it's up to you. Just make sure you cna use your binder efficiently. At the end (or somewhere else easily accessible), I would include a copy of the Geologic Time Scale (https://www.geosociety.org/documents/gsa/timescale/timescl.pdf or http://www.stratigraphy.org/ICSchart/ChronostratChart2018-08.pdf). I also had a few pages that listed information about each mode of preservation, each Lagerstätte, etc.

Example 1

Identify the corals:

_____ *Favosites*
_____ *Halysites*
_____ *Heliophyllum*
_____ *Hexagonaria*
_____ *Septastrea*

This and the following examples are from the 2016 NCSO State competition. Each example was an individual station (one of about 20) at the event.

These may be somewhat atypical in including a lot of physical specimens, since at a lot of regional competitions it can be hard to procure good specimens. With that in mind, realize that many competitions will use printed images of fossils, prehistoric organisms, and other material, rather than (or more than) real specimens. This test is also a bit more advanced than you might see at regional competitions, and happens to be all matching and true or false questions. I don't know whether the State test will be quite the same format this year, but it and other regional tests will likely cover comparable material.

This question requires the contestant to distinguish between related groups of fossil organisms. ID images would be very helpful for this task.

Example 2

Many fossil remains are fragmentary. Match each fragment with its identity:

_____ Cetacean rib

_____ Cetacean limb element

_____ Dinosaur rib

_____ Turtle shell

_____ Crocodilian skull

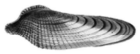
This station focuses on morphology. Mammalian bones, dinosaur bones, and reptile shells/scutes have different structures (differences in porosity, size, shape). Skulls and limb elements may have characteristic shapes. Resources in your binder likely won't help with this kind of event. Instead, I would recommend trying to get a lot of familiar with what physical specimens look like if possible. Looking at several different images can be helpful. Note that this kind of question is much more specimen-oriented, so it might not occur at a regional competition.

Example 3

Match each of the animals pictured here with its most likely trace fossil:

____

____



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This station focuses on trace fossils. Different groups leave different sorts of tracks. Some organisms leave burrows (top right in the image) and borings (top left). It's important to understand how a trace fossil relates to a specific group and the behaviors of certain organisms.

Example 4

Use the NC Geological Survey map found at this Station to decide if each of the following is true or false.

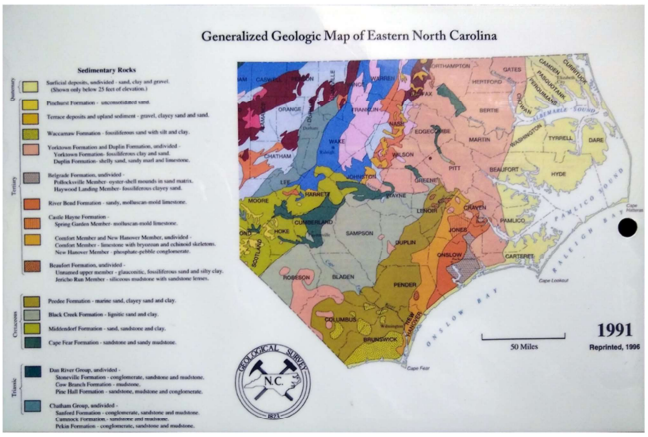
_____ If you travel east from Fayetteville to Beaufort, the rock strata dip toward the east

_____ There are no fossil deposits in Chatham and Lee Counties

_____ The rocks exposed in Bladen County are the right age to contain dinosaur remains

_____ Trilobites have been found in Edgecombe County fossil deposits

_____ *Plesiosaurus* teeth are occasionally found in eastern North Carolina fossil deposits



This station integrates and applies an understanding of the Geological Time Scale with knowledge about geological processes and the ages of different fossil organisms. Note that contestants aren't expected to know what the map looks like in advance (it is provided at the event). The important part is recognizing that rock formations from the Jurassic versus Cretaceous versus Cenozoic etc. are (1) organized layers (youngest on top) and (2) coincident with organisms from the same age.

Example 5

Many famous fossils are identified with a particular location. Associate each location listed here with the most appropriate specimen in the photograph.

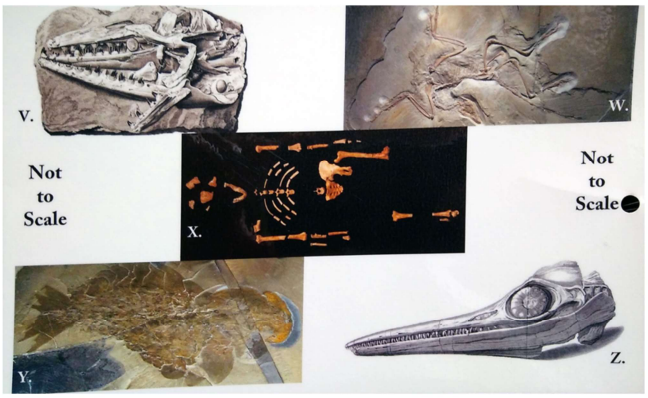
_____ Burgess Shale, Canada

_____ Hadar, Ethiopia

_____ Lyme Regis, England

_____ Maastricht, Netherlands

_____ Solnhofen, Germany



This station focuses on Lagerstätten. You should know the time periods and major groups of fossil organisms associated with each. For example, the Burgess Shale is associated with a diversity of early invertebrates from the Cambrian. Note that not all of the sites referenced in this question are in the rules anymore. See the updated rules to be sure, but I think this year's sites are Burgess Shale, Beecher's Trilobite Bed, Mazon Creek, Ghost Ranch, Solnhofen Limestone, Yixian Formation (Liaoning), Green River Formation, and LaBrea Tar Pits.

Example 6

Identify the various trilobite parts:

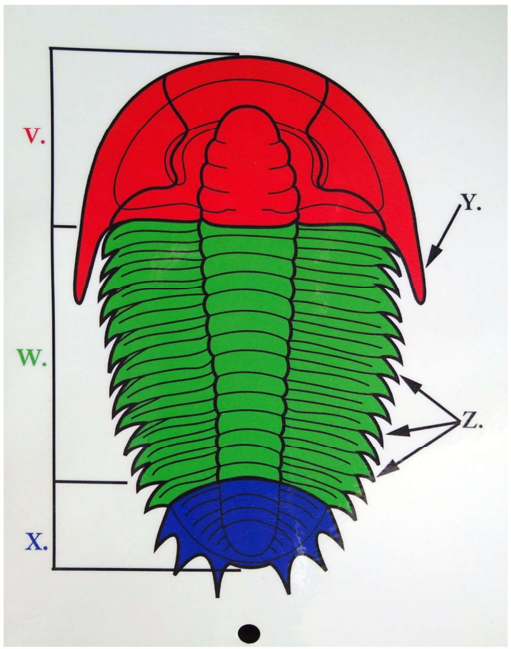
_____ Thorax

_____ Pleural spine

_____ Pygidium

_____ Cephalon

_____ Genal spine



For most groups, comparative anatomy is the only thing to worry about. For example, mammals and reptiles have different skull features, dinosaurs can be divided into “bird-hipped” and “lizard-hipped”. For a few major groups, you might want to know a little more detail (e.g. trilobites, ammonites). I suspect this is a more likely question on Division C tests than Division B.

Final Comments and Questions

- Some in-person resources
- Possible differences in regional competitions
- Being competition-ready

- Questions?

I hope this presentation was helpful. To close off, I'd be glad to answer any questions.

Some further (mostly free) resources that might be helpful: Local/state museums and universities. The NC Museum of Natural Sciences and the Aurora Fossil Museum have informative exhibits/specimens. You may be able to contact some museums and university geology departments to learn more, ask questions, see specimens. The North Carolina Fossil Club (my family has a membership with this group). This club is based in Raleigh, but has members around the state. Contact the club to find out what resources its volunteers may be able to provide you with. The club's annual Fossil Festival is being held at the Museum of Life and Science in Durham on 3 November 2018. The museum charges attendance, but this may be a great resource to see several displays and knowledgeable fossil enthusiasts. The event typically displays several specimens, and you can ask presenters about fossils.

The Best of Luck to all coaches and contestants this year! Happy studying!