Making Tracks:

Dinosaur Footprints

Scientists and amateurs have been finding dinosaur footprints for hundreds of years, even before anyone knew what they were. In 1802, a Massachusetts farm boy ploughed up a rock bearing the footprints of a three-toed animal. In the 1830s, Edward Hitchock, the president of Amherst College, excavated and described thousands of tracks. He published the results of his work in 1858, a book that is still used today. Hitchcock believed that the tracks were made by ancient bird-like animals; based on the narrow tail marks that often occurred with the footprints, he concluded that these animals had long, reptile-like tails.

By the late 19th century, scientists knew more about dinosaurs and concentrated on the study of body fossils, paying little attention to footprints and other trace fossils. It wasn't until the 1980s, when the study of dinosaurs enjoyed a resurgence, that scientists again looked closely into footprints and trackways. Now, new discoveries are being made all the time. Fossils of dinosaur footprints outnumber body fossils – after all, a dinosaur could leave only one skeleton, but it could make countless tracks during its lifetime! Footprints are found in quarries, mines, riverbeds, deserts and mountain terraces. But it is important to remember that the settings in which the tracks were made differed considerably from the modern landscape where the fossil footprints are found. Dinosaurs made tracks in the kinds of places one commonly sees tracks today: along shorelines, on tidal flats and shallow lake bottoms, on muddy pathways and recently drained puddles – anywhere large expanses of moist sediment are found.

If the conditions were just right when the prints were made, a well-preserved fossil will show details such as the claws or nails, the shape of the pads and even the pattern or texture of the skin. But this degree of preservation is very rare. What is known from studies of both body and trace fossils is that dinosaurs usually walked on their toes, just like dogs, cats and chickens. Scientists call this kind of walking *digitigrade*. People, bears and crocodiles walk differently – flat-footed or *plantigrade*. Dinosaurs also walked with their toes pointed inward, almost “pigeon toed”. It is not surprising that many early studies of trackways ways were believed to have been left by large ancient birds – bird and dinosaur footprints are similar.

Information on dinosaur behaviour, social structure and physical environment can be revealed by studying their prints. Dinosaur trackway studies suggest that some species moved about in herds, like caribou and elephants. The occurrence of many different types of tracks at one site indicates that many animals used the same path or trackway. A trackway showing the footprints of both a plant eater and a meat eater may represent a hunt in progress. Because many footprints were preserved on shorelines, near lakes or the ocean, a fossil trackway reveals where an ancient shoreline may have been, giving researchers a glimpse into the past environment of the dinosaur.

Generally, the best information a dinosaur track can provide concerns locomotion, the way the animal moved. Trackways can indicate whether a dinosaur was walking, trotting, running or wading. Some dinosaurs were bipedal (they walked on two legs, as humans do) and others were quadrupedal (they walked on four legs). Trackways reveal how dinosaurs walked, on two or four legs.

The approximate speed of an animal can also be calculated from the footprints it leaves behind. In 1976, the British zoologist R. McNeill Alexander used elephants, birds, people and many other living animals to formulate an equation relating tracks to speed, leg length and stride length. Using McNeill’s formula, scientists can determine the walking or running speed of dinosaurs. The work undertaken by ichnologists (scientists who study trace fossils) has revealed much about dinosaurs. Who knows what else will be learned from these ancient footprints.

LEVEL: Minimum Grade 3

OBJECTIVE: Students will begin to understand how scientists can use something as simple and seemingly insignificant as a footprint to determine size, shape and many other facts about an animal.

EXERCISE:

In this activity students will learn to calculate the length of an animals leg from measurements taken from their footprints. As in most cases, where fossil footprints are found, there are no bones there to give us information about the animal's size. The only measurements available from a trackway relate to the foot size and stride length. The length of the creature's leg (the hip height) can be determined from the foot length. Scientists have already determined that the leg length (H) for dinosaurs is roughly four times the length of the foot (F). For example, if a footprint measures 0.5 metres long, the creature's leg length is about 2 metres (H = F * 4).

Once scientists have established the leg length (hip height) from an animal's footprints, they can calculate the walking speed. Using a complicated equation, R.A. Thulborn (1982, University of Queensland, Australia) has calculated the following speeds:

- Sauropodamorphs: up to 5 km/h (about the walking speed of people).
- Stegosaurs and ankylosaurs: 6–8 km/h.
- Most sauropods walked 12–17 km/h and could run 20–30 km/h.
- Large theropods (like T-rex) and ornithopods: up to 20 km/h.
- Ceratopsians: up to 25 km/h.
- Small theropods and ornithopods: up to 40km/h.
- Ornithomimids: up to 60 km/h.
- People walk at about 5 km/h and can run up to 23 km/h (sprinting).

Students are required to determine *only* the leg length. Taking measurements of their own footprints and comparing the results to their actual leg length, students will begin to understand how scientists estimate the size, shape and speed of long-extinct animals from only their fossil remains.

PROCEDURE:

Students may proceed in several ways. Each student can simply measure their own foot and calculate the leg length (H) at four times the length of their foot (F). Or they can create their own trackway. Footprints can be made and measured in the snow or on sand, if a beach is nearby. Indoors, you can use a roll of paper and pan of water. Roll out a metre-long piece of paper for each student. After removing shoes and socks, they dip their feet in the water and walk across the paper leaving their foot prints behind.

After the calculations are done, students should measure their actual leg length, from the top of the hip to the ankle. The top of the hip is where the ball of the femur joins the pelvis. Once they have both the estimated and true leg lengths, they can make comparisons and discuss their findings as a group. Are the estimated and the true lengths the same? If not why do they think this is so?