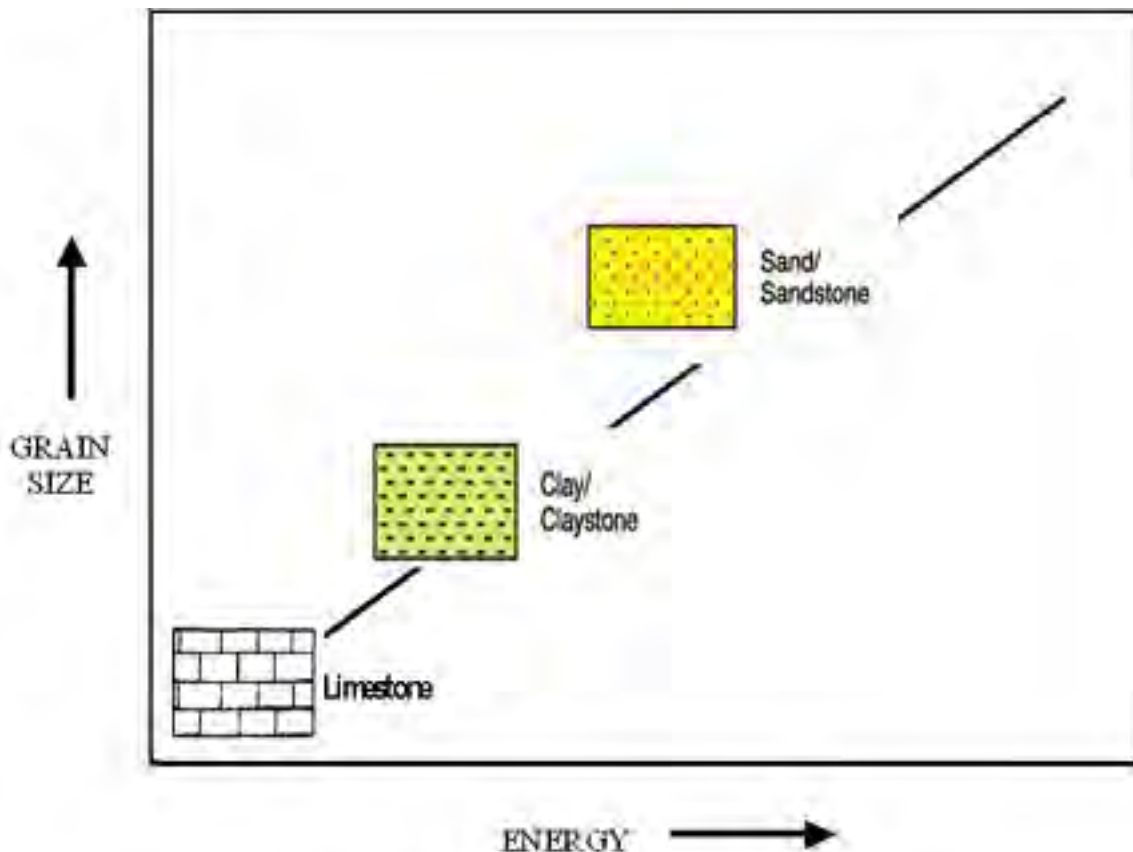


The WOODBINE FORMATION: Understanding Dinosaurs from their Tracks

The Woodbine Formations is a rock unit comprised mostly of the sedimentary rock sandstone. Sand is a particle size, as are clay and silt. Of the three, sand is the coarsest. You can see and feel the individual grains. Clay is the finest particle size. You cannot easily see the individual grains of clay. You can think of clay like a chocolate bar; when you bite into it, there is no grit. In fact, clay is used as a filler in chocolate bars. The sand grains of the Woodbine Formation are mainly composed of the mineral quartz.

The size of particles that comprise sedimentary rocks provide important clues about the environment in which the sediments were deposited. As a general rule, in water laid deposits, the larger the grain size, the higher the energy of the water necessary to transport the grains, as shown in the figure below. Thus, in a deposit like the Woodbine that has little clay but lots of sand, the water from which the sand grains were deposited had enough energy to carry away most of the clay and silt, leaving behind the sand.



A simple diagram to demonstrate the relationship between sediment grain size and energy flow in the development of different types of sedimentary deposits. Higher energy is required to transport and deposit larger sediment grains.

After its deposition at sea level, the Woodbine was buried by hundreds, if not thousands, of meters of younger sediment, which has since been eroded away to be exposed once more on the surface. While it was buried, the soft sands were dewatered and lithified to sandstone. Ground waters percolating through the pores and spaces of the sandstone left iron mineral crusts and concretions. These younger diagenetic minerals are superimposed on the original Woodbine sediments and the structures developed in it while it was soft.

Two SMU graduate students have studied vertebrate fossils from the Woodbine Formation. One named the new duck-billed dinosaur *Protohadros byrdi* and the other named a new crocodylian *Woodbinesuchus byersmauricei* and described the remains of an armored dinosaur and a meat-eating dinosaur. The oldest opossum known from Texas is represented by a fossil tooth found in the Woodbine at DFW Airport. Flowering plants are shown to have taken over from conifers by the fossil plants found in the Woodbine.

One of the most interesting sets of structures found in the Woodbine Formation are two kinds of dinosaur tracks and the tracks of a purported bird studied originally by SMU graduate student Yuong-Nam Lee. These tracks are, of course, fossils because they are evidence of past life. They are also sedimentary structures, and they also can inform us about the animals that made them. Two figures from Lee's (1997) study show line drawings of the track and a measured section of the rocks placing them in stratigraphic position.

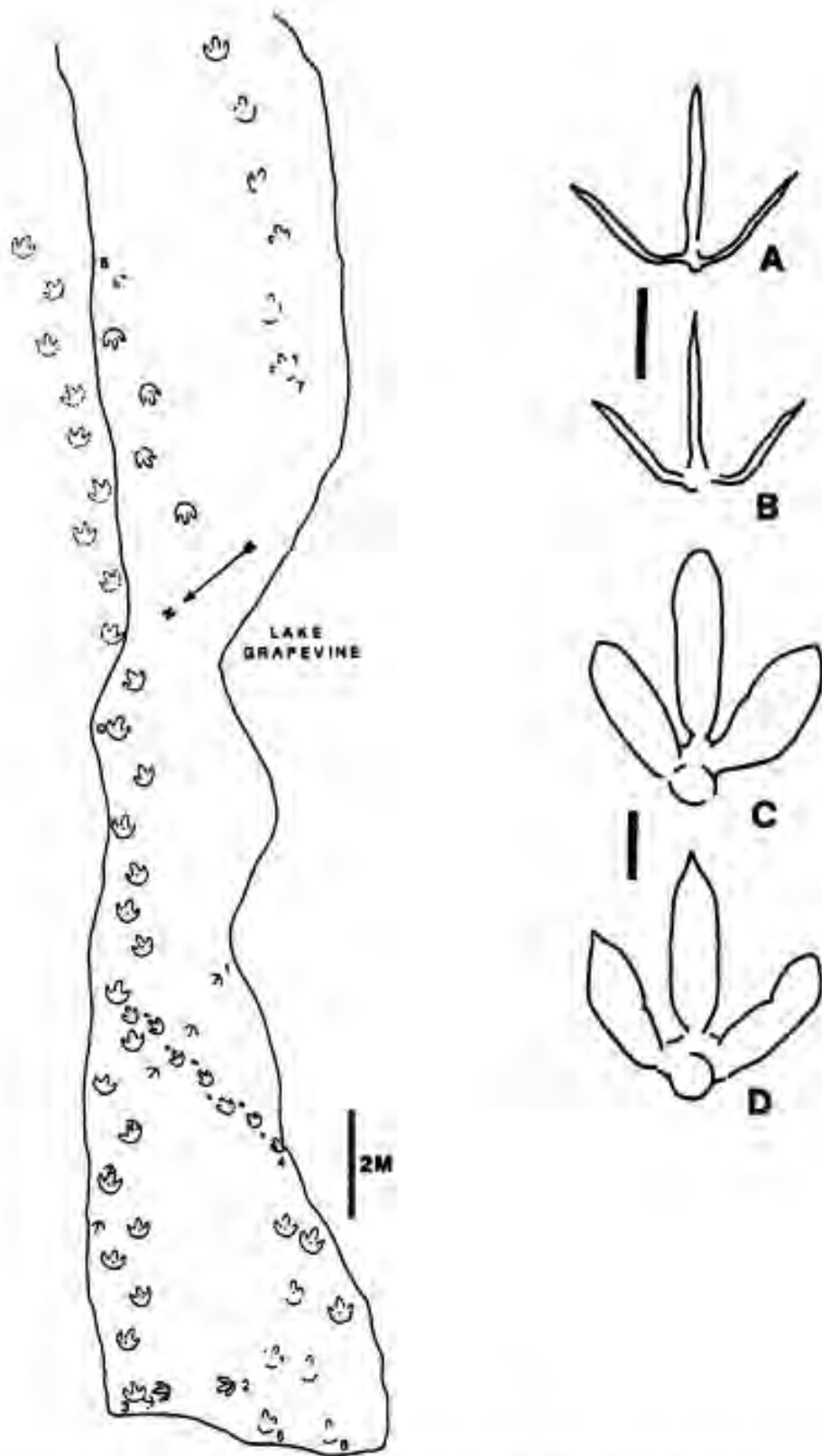


Figure 3. Map showing the distribution of trackways in the Woodbine Formation at SMU locality 234, Grapevine Lake, Texas. Stippled footprints were mapped by staff of the Dallas Museum of Natural History. A, *Magnoavipes lowei*, holotype (DMNH 918); B, *Magnoavipes lowei*, paratype; C, *Fuscinapedis woodbinensis*, holotype (SMU 74651); D, *Fuscinapedis woodbinensis*, paratype. Scale bars = 10 cm.

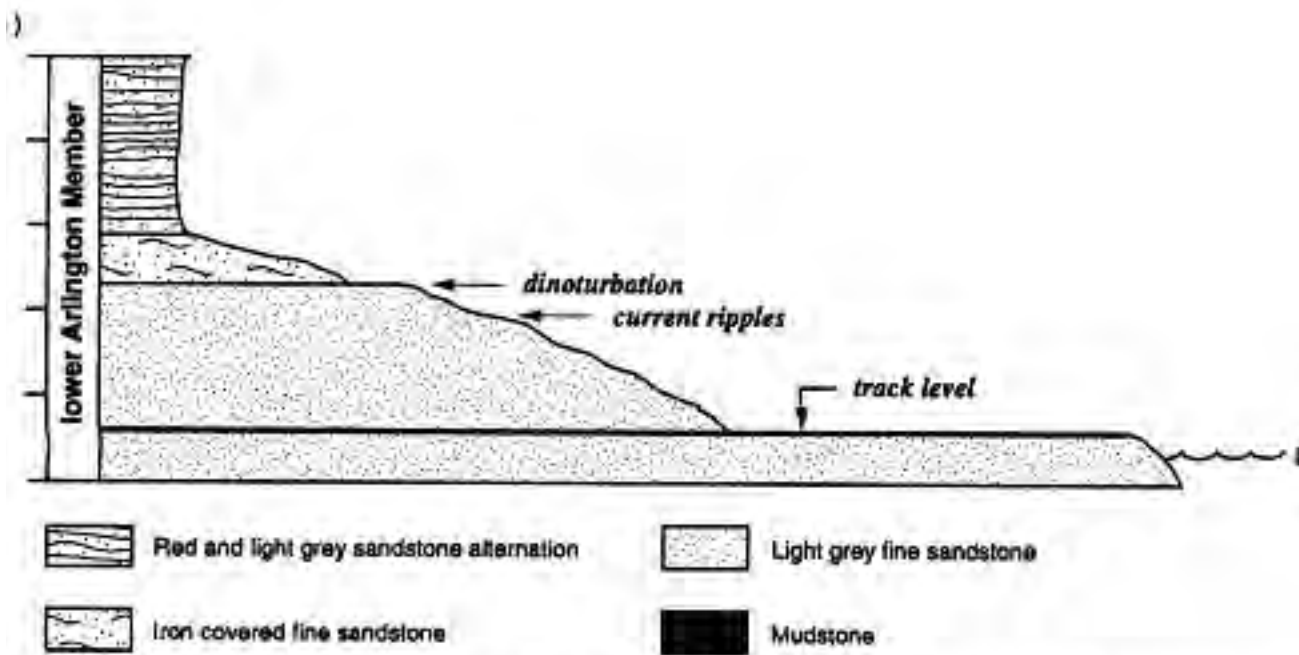


Figure 4. Stratigraphic section of the Woodbine Formation showing track-bearing horizons exposed at Grapevine Lake, Texas (SMU locality 234).

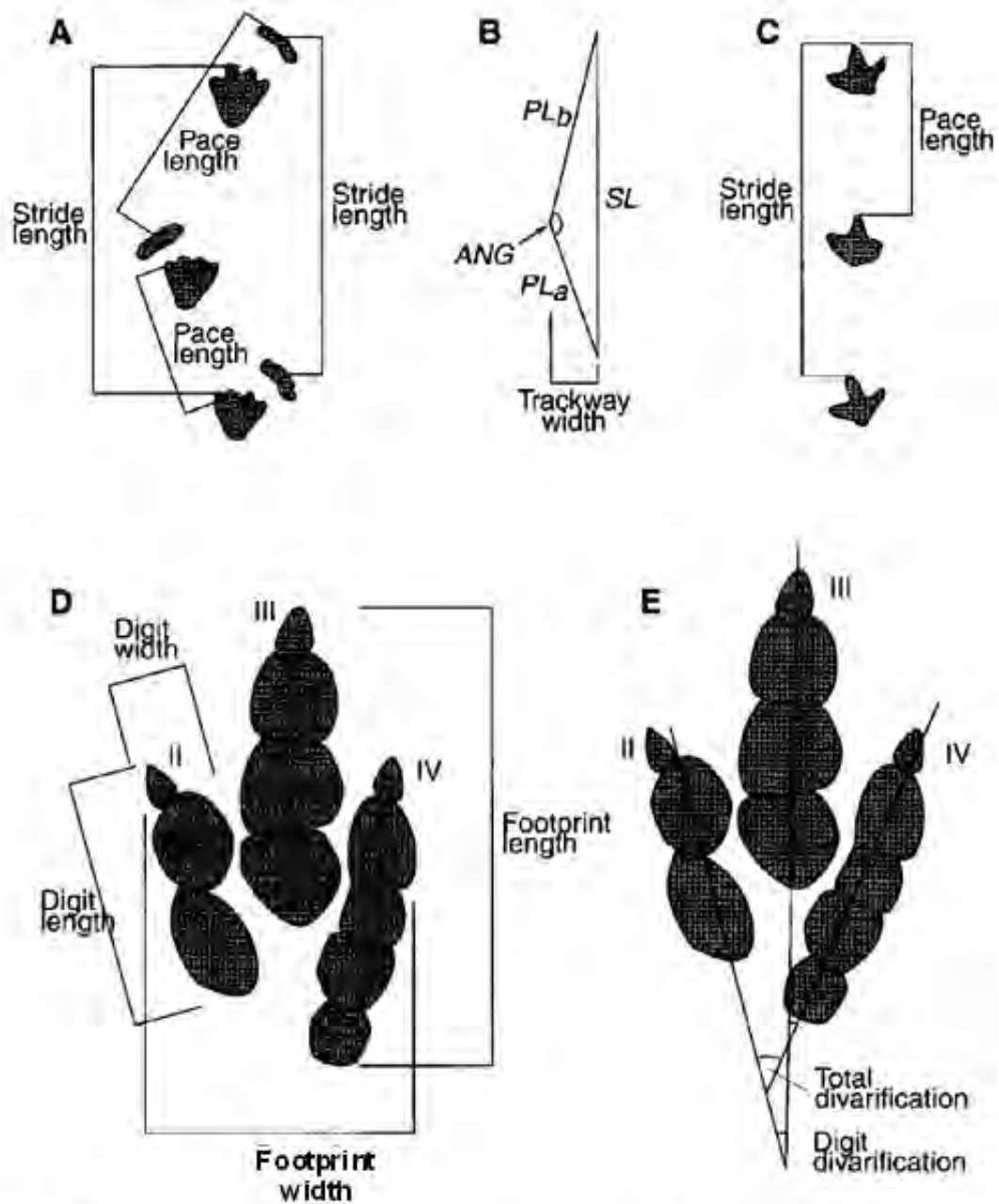


Fig. 1. Measurements of footprints and trackways. **A.** Pace length (PL) and stride length (SL) in a trackway of a bipedal dinosaur. Measurements can be taken from any point in the foot as long as the point used is specified and it can be easily identified on each footprint. For this reason the back of the heel or the tip of the middle toe are often used. **B.** The angles of the trackway angulation pattern; these are used as a measure of how in line the footprints are with one another. **C.** Pace and stride lengths in a quadrupedal trackway. Manus and pes trackways are treated separately. **D.** Measurements of footprint and digit lengths and widths. **E.** Measurement of divarification angles between the digits in a typical theropod track.

From Wright and Breithaupt, 2002.

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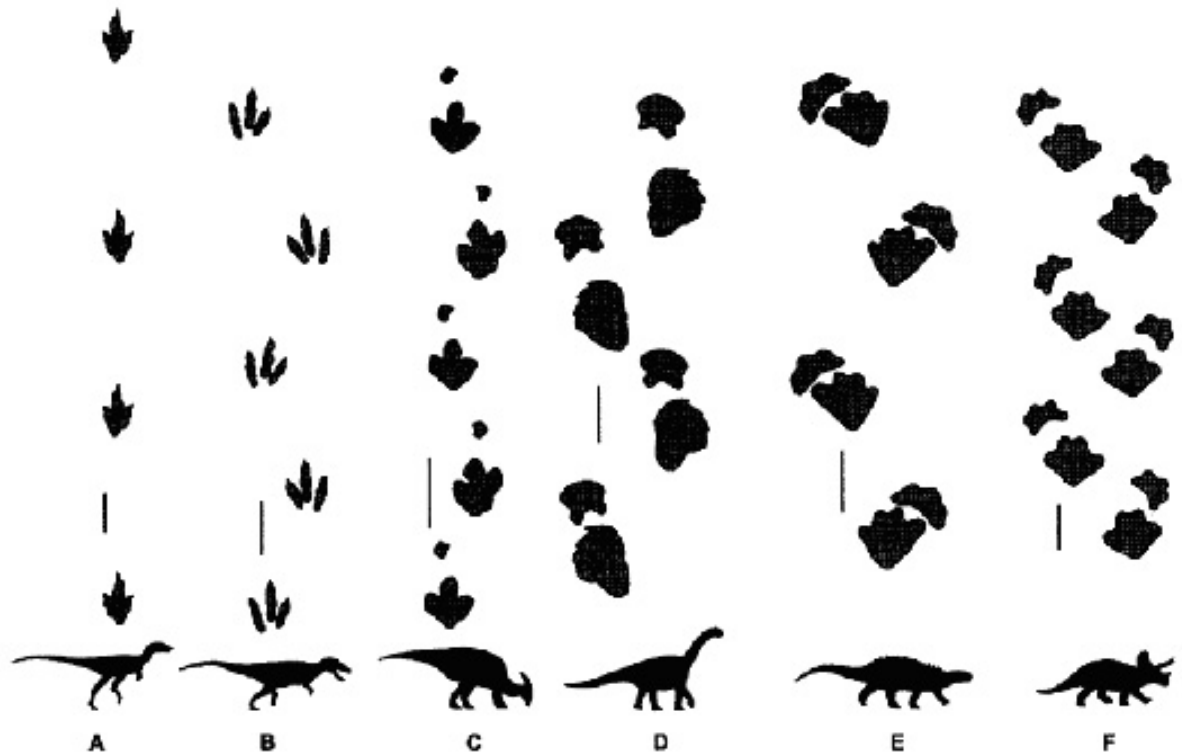


Fig. 2. Some common dinosaur trackways and their producers. A. *Grallator* trackway probably made by a small theropod such as *Coelophysis*. B. Large theropod trackway probably made by an allosaurid or megalosaurid. C. *Caririchnium*, large quadrupedal ornithomimid trackway probably made by an iguanodontid or hadrosaurid. D. *Bronropodus* trackway probably made by a brachiosaurid/camarasaurid sauropod. E. Large quadrupedal trackway probably made by a nodosaurid ankylosaur. F. *Ceratopsipes* trackway probably made by a horned dinosaur. (B and E redrawn after Wright, 1996; C, D and F redrawn after Lockley, 1989)

From Wright and Breithaupt, 2002

Equations for determining hip height and speed (Alexander, 1989 and Thulborn, 1990)

$$\text{hip height (h)} = \text{Foot length (FL)} \times 4$$

$$\text{Actual speed (V)} = 0.25g^{0.5} \times \text{SL}^{1.67} \times h^{-1.17}$$

(V= velocity (m/s), g = gravity constant (9.8 m/s), SL = stride length, and h = hip height, all in meters)

$$\text{m/s} \times 3.6 = \text{kmph}$$

$$\text{kmph} / 1.6 = \text{miles per hour}$$

Relative stride length, L/h, where L is the average stride length and h is the hip height (calculated above)

<u>L/h</u>	<u>Gait</u>
< 2.0	Walking
2.0 - 2.9	Trotting
>2.9	Running

Dinosaur Tracking Worksheet

Assignment:

Complete the following steps for each of the dinosaur trackways. All measurements are in meters (m). Actual speed will be reported in meters per second (m/s) and miles per hour (mph). Figure 1 shows how the various measurements are made on fossil trackways.

1. Measure foot lengths for several tracks within a single trackway. Average the foot lengths.
2. Measure several stride lengths within a trackway. Average the stride lengths.
3. Calculate the hip height, using equations given and avg. foot lengths.
4. Calculate actual speed in meters per second. Convert m/s (meters per second) to mph (miles per hour).
5. Calculate the Relative Stride Length.

NOTE: Calculate and round all values to 2 decimal places.

FL1 _____

SL1 _____

FL2 _____

SL2 _____

FL3 _____

SL3 _____

FL4 _____

SL4 _____

FL5 _____

SL5 _____

Avg. FL _____

Avg. SL _____

Hip height _____

Actual speed (m/s) _____

(mph) _____

Relative stride length _____

Attach additional paper to show all calculations to receive full credit.

