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The Rocky Hill Dinosaurs

Ostrom, John H.

Quarrier, Sidney S.

Trip C-3

THE ROCKY HILL DINOSAURS

by

John H. Ostrom
Yale University

with an Introduction by

Sidney S. Quarrier
Connecticut Geological and Natural History Survey

INTRODUCTION

On August 24, 1966, excavations were under way for the foundation of a Connecticut State Highway Department testing laboratory in the Town of Rocky Hill. Edward McCarthy, a bulldozer operator, noticed that his machine had uncovered a slab of rock bearing oddly shaped tracks; and, thinking that the tracks might hold some significance, he stopped his machine and called the attention of the engineer to his find.

In a rapid succession of events, interested personnel were notified of the discovery; its scientific and educational values were determined; and with a speed rare in government circles, steps were immediately instituted through the direct action of Governor John Dempsey to preserve the tracks in place. The area is now Dinosaur State Park, Rocky Hill, Connecticut.

The tracks at Rocky Hill are in a sequence of gray arkoses and gray shales in the East Berlin Formation. This sequence has been tentatively correlated with the first gray sequence that is exposed below the Hampden Basalt in the roadcuts of Stop 5, Trip C-1. The tracks are best preserved in the arkosic units as the bedding planes are well developed. The trackway strikes N 85 E and dips 7°-10 S. The rocks exposed here are on the south flank of a broad anticlinal structure that gently plunges to the east toward the border fault. This is one of a series of similar structures that occur along the length of the eastern border fault of the Triassic basin. The origin of these structures is not positively known but has been attributed both to differential compaction rates and to differential displacement along the fault to the east.

The Hampden Basalt is exposed on the hill just to the south of the trackway. The arkosic units display excellent ripple marks, raindrop impressions, mud cracks and cross bedding. A small fault that strikes ENE is exposed at the base of the trackway. An apparent vertical displacement of 18 feet was calculated from two core holes that were drilled last summer. The horizontal displacement is not known. The sheared zone of

Figure 1. The footprint horizon at Rocky Hill at an early stage of excavation showing the density and extent of the footprints. (Photo by John Howard, Yale Peabody Museum of Natural History.)

this fault is well exhibited in an outcrop at the park.

John Byrnes of the University of Connecticut is completing a study of the sedimentary rocks.

The largest area of tracks is still covered under a plastic protective blanket. The future of this area is uncertain but some exposure of it is planned for next year. The bubble building exhibits a smaller area of tracks and this is expected to be open for the field trip.

THE ROCKY HILL DINOSAURS

Discovery of dinosaur footprints at Rocky Hill during August of 1966 is the most recent and spectacular event in a long history of fossil footprint discoveries in the Triassic rocks of the Connecticut valley. The earliest known discovery dates back to the year 1800 and was made by a Williams College student named Pliny Moody near South Hadley, Massachusetts. Moody thought his find was a footprint left by some giant ancient bird and believing the rocks in that area to have accumulated as sediments during the biblical flood, he referred to it as "Noah's raven".

Some 35 years later, Edward Hitchcock, Professor of Geology and President of Amherst College (and also State Geologist of Massachusetts) was informed of "turkey tracks" preserved on sandstone slabs in the town of Greenfield. Hitchcock apparently was greatly impressed by these "turkey tracks" for he immediately began what turned out to be a lifelong search for additional examples of ancient bird tracks in the stone quarries up and down the Connecticut River valley. His search produced a surprising variety of fossil footprints which he interpreted as proof of the existence of very ancient birds - a conclusion contrary to the generally held opinion that birds had not existed during such ancient times. This in fact, was the main conclusion of his first report (1836) on bird footmarks from the "New Red sandstone". In his quest for "ornithichnites", Hitchcock amassed a large collection of footprints (now in the Amherst College Museum) and published numerous reports on their occurrence. Best known of these reports is his large volume of lithographs "Ichnology of New England" published in 1858.

In subsequent years, the Connecticut valley became famous for its fossil footprints (Lull, 1953). More than a hundred sites are now known in Connecticut and Massachusetts and since Moody's initial find literally thousands of footprints have been collected. Most finds have consisted of solitary prints or only short sequences of three or four prints in a single trackway. With a few exceptions (Mt. Holyoke, Turner's Falls, Middlefield) no sites suitable for <u>in situ</u> preservation had been located until the discovery of the Rocky Hill footprints.

The Rocky Hill site is remarkable in that it is perhaps the largest (more than 35,000 square feet) known exposure with abundant fossil footprints preserved on a single bedding plane. There are other impressive

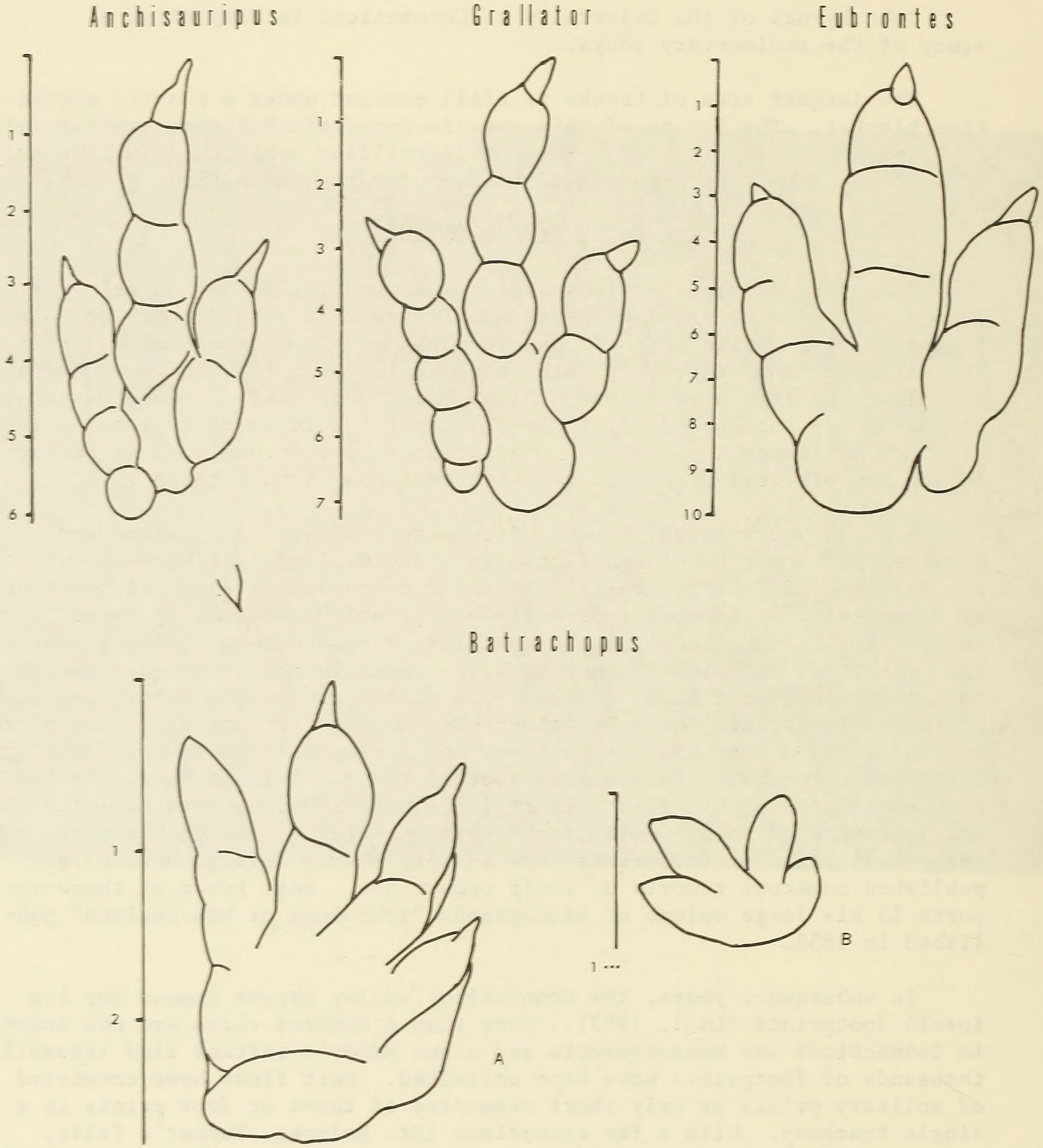

Figure 2. Comparison of the four kinds of fossil footprints so far identified at Rocky Hill. All are drawn to the same unit length to show similarities. Notice the close resemblance between Anchisauripus and Grallator. The Eubrontes print is of the same general type, but is broader and more massive, as well as larger. The vertical scales in inches indicate actual sizes. Batrachopus: A = left hind foot; B = left fore foot.

footprint sites (Arizona, Texas, Basutoland), but all are in remote or wilderness regions and are quite impractical to preserve. To date, more than 1,000 footprints have been studied and identified in less than one fourth of the area presently exposed at Rocky Hill. Aside from the impressive spectacle of so many footprints and such a large expanse, this site contains an unusual record of a "single moment" in Triassic time (fig. 1). It provides documentation of an ancient community of dinosaurs and related reptiles as living creatures approximately 200 million years ago. This record is preserved on a large expanse of a single bedding surface - a bedding surface that could well represent an interval of less than 24 hours duration. Rocky Hill can provide us with new information on animal associations, habits and movement that cannot be obtained from other presently known Triassic fossil sites.

In the absence of detailed knowledge about Triassic dinosaurs and other animals of that time, Moody's and Hitchcock's avian identifications were not unreasonable; many of the Connecticut prints are distinctly bird-like. We now know however, that they are the trails of several different kinds of extinct reptiles - dinosaurs in particular. Because of the extreme rarity of fossil skeletal remains from Connecticut Triassic rocks it is necessary to compare the several kinds of footprints with skeletal evidence from the Triassic of other parts of the world. Such comparisons cannot provide absolute identifications, but they do establish the general kinds of animals that were involved.

To date, three (possibly four) distinct kinds of footprints have been identified at Rocky Hill. In order of decreasing abundance, they are:

Eubrontes giganteus *

Anchisauripus sillimani *

Batrachopus dispar *

The first two kinds are rather similar, differing chiefly in details, proportions and size. Both were made by bipedal animals with feet that were functionally three-toed. Batrachopus dispar is quite different and was made by a quadrupedal animal in which both the hind and fore feet had four functional toes. A few prints have tentatively been identified as Grallator cuneatus *. Other kinds may be recognized as excavation work is continued and detailed studies made.

While our knowledge of Triassic land animals is still incomplete, the only animals presently known with tridactyl feet and bipedal posture are certain kinds of dinosaurs. Currently, dinosaurs are classified in two major groups (Orders) - the Order Saurischia, which includes the great brontosaur-like animals and their relatives, and all carnivorous dinosaurs and, the Order Ornithischia, the horned, plated, armored and duckbilled dinosaurs. Of these, only the carnivorous saurischians (theropods) and the duck-billed ornithischians (ornithopods) had tridactyl feet

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* These names refer to the footprints - not to the animals that made them. We can never be certain of that identity.

and were bipedal. Ornithopods may have existed in the Connecticut region during Triassic times. Certain other footprints found elsewhere in Connecticut though not as yet recognized at Rocky Hill, are usually attributed to primitive ornithopods but these animals appear to have been rare prior to Jurassic times. It is only in the last half dozen years that ornithischian remains have been positively identified from Triassic rocks anywhere in the world. The carnivorous dinosaurs are commonly separated into two kinds - small, lightly built and presumably fast-moving predators (coelurosaurs) and large, heavily built and probably slower-moving animals (carnosaurs), (fig. 3). Both kinds were exclusively bipedal and had tridactyl feet.

Fragmentary remains of at least one kind of small coelurosaur have been found in the Connecticut valley. (Colbert and Baird, 1958). The anatomy of this animal, Coelophysis, fortunately, is well known from a number of complete skeletons from the Triassic of New Mexico. The structure of its foot and the size of the animal are perfect matches with Anchisauripus footprints. Figure 5 is an artist's reconstruction of how Coelophysis may have appeared. A Coelophysis-like animal may also have been responsible for those prints identified as Grallator, for the shape and size of Grallator prints are very close to Anchisauripus prints (fig. 2). The principal differences between the two are: the faint impression of the first or "great toe" at the rear of the footprint in Anchisauripus, but not in Grallator; and, the relatively greater length of the stride in the latter. Both differences could easily have resulted from differences in movement (walking vs running). In view of the overall similarities between the two "kinds" of footprints I am inclined to think both were made by a single kind of animal - a Coelophysis-like coelurosaur.

At present, no skeletal remains of any animal are known that match the much larger and broader footprints (Eubrontes) that dominate the scene at Rocky Hill. However, in view of the general similarity to the prints already described, there is the possibility that they were made by a much larger coelurosaur. Nevertheless, I am inclined to think they were produced by one of the primitive members of the "carnosaurs" - the larger and more ponderous dinosaurian predators. This interpretation seems quite reasonable, except that no fossil skeletal remains of carnosaurs are known from this region. In fact, Triassic carnosaur remains are exceedingly rare, although there are several incomplete specimens from the Triassic of western North America (Megalosaurus wetherilli[1] and Poposaurus gracilis[2]) that may be carnosaurian. In view of the apparent absence of Triassic carnosaurs in the Connecticut area, another possible explanation is favored by some paleontologists. They note that the most common kind of dinosaur so far encountered in the Connecticut Triassic is neither coelurosaur or carnosaur, but belongs to another very different group of saurischian dinosaurs called prosauropods. The prosauropods included herbivores and carnivores as well as the ancestral stock of the great Brontosaurus-like dinosaurs. Most prosauropods were bipedal - at least part of the time - but the foot structure of all prosauropods was four-toed. It is possible that the short, inner toe did not make contact

[1] (Welles, S. P., 1954)

[2] (Colbert, E. H., 1961)

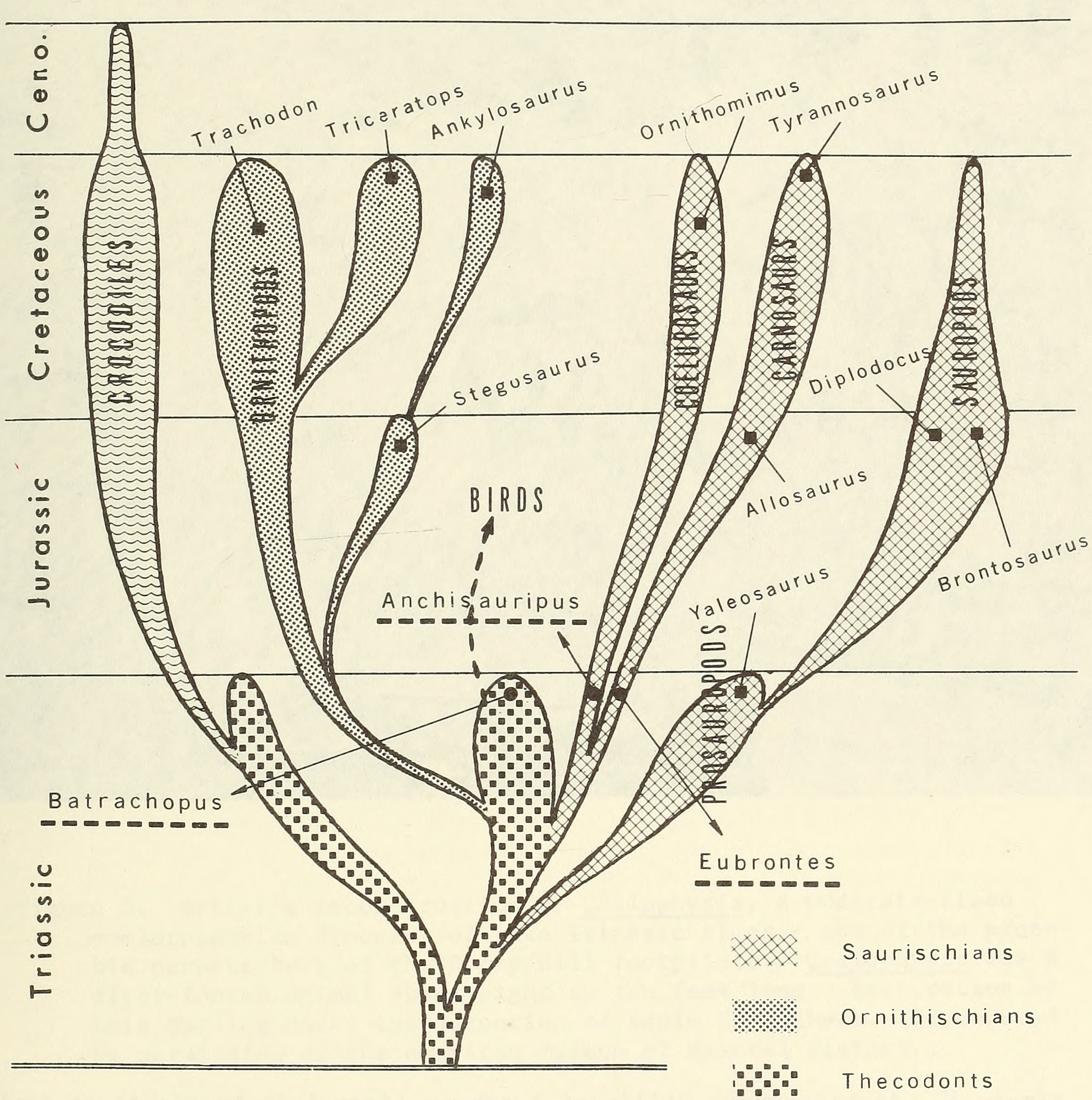

Figure 3. Family tree of dinosaurs and related reptiles of the Mesozoic Era. Several well-known kinds of dinosaurs are identified in each major group and the Rocky Hill footprints are marked.

Figure 4. Anchisauripus sillimani trackway (from left to right) at Rocky Hill, Connecticut. This limited area shows the progression of one animal from relatively firm mud at an ancient shoreline (left) into soft, water-saturated and ripple-marked mud beyond the shoreline. The traverse of a second, smaller animal - apparently another coelurosaur - is preserved trending from the right foreground to the upper left and several faint invertebrate trails are visible. Here is the record of a Triassic "mud hole". (Photo by John Howard, Yale Peabody Museum of Natural History.)

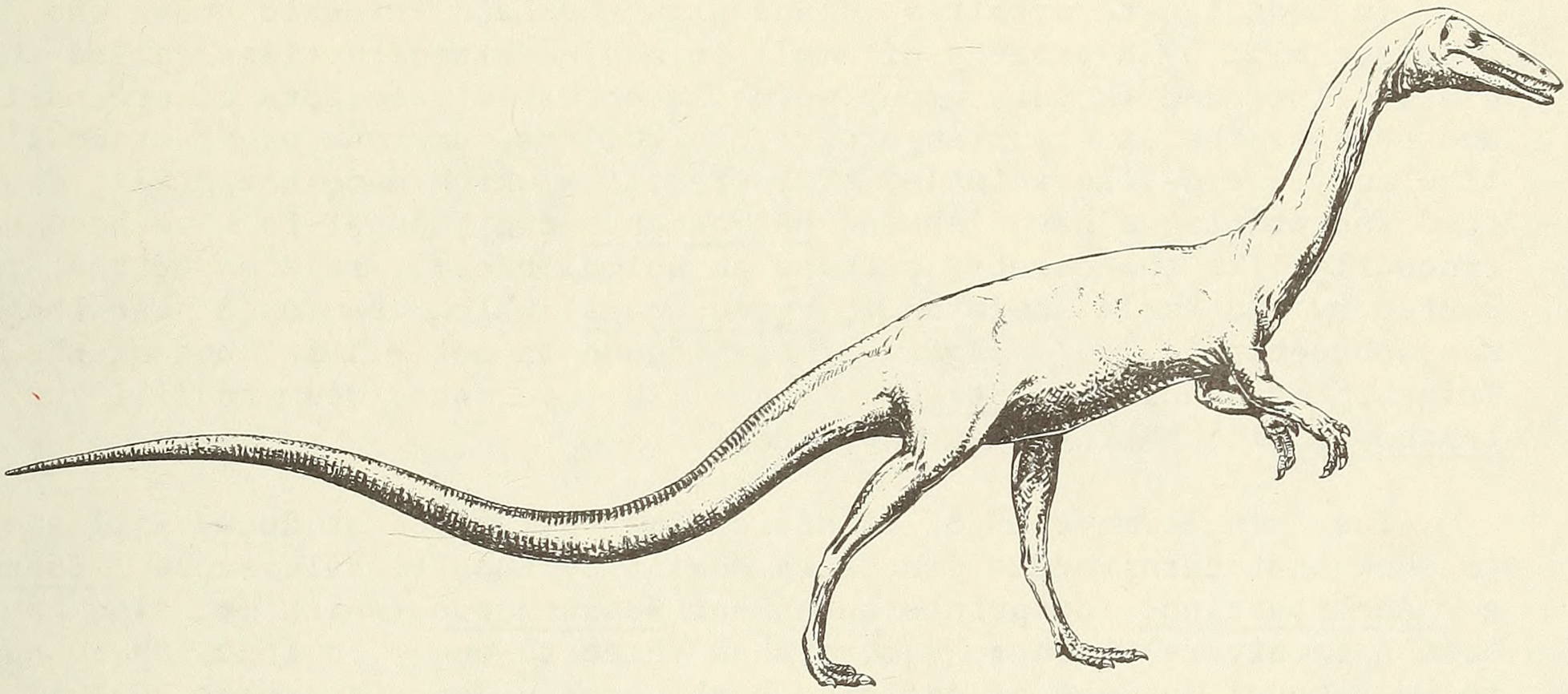

Figure 5. Artist's reconstruction of Coelophysis, a moderate-sized coelurosaurian dinosaur of Late Triassic times - one of the probable perpetrators of the Rocky Hill footprints. Coelophysis was a fleet-footed animal about eight to ten feet long. Restoration by Lois Darling under the direction of Edwin H. Colbert. (Reproduced by permission of the American Museum of Natural History.)

with the ground and thus prosauropods could have left three- rather than four-toed footprints. While correlating the most common footprint kinds with the most frequently found (four specimens) kinds of skeletal evidence is reasonable, in view of the obvious structural discrepancies in this case it does seem highly questionable. Moreover, there are abundant, four-toed footprints of some ancient biped (Otozoum) from many other New England sites that correspond very closely in form and size to prosauropod foot structure. Accordingly, I prefer to believe the Eubrontes type prints were made by some moderate-sized carnivorous dinosaur - possibly carnosaurian - not as yet known from skeletal evidence.

In addition to primitive dinosaurs, the Late Triassic scene was also occupied by a variety of small to medium-sized reptiles called thecodonts. Included in this group were the probable ancestors of crocodilians and both of the dinosaurian orders, as well as numerous other crocodile-like and lizard-like animals. The creatures which made the small, four-toed footprints we have labeled Batrachopus are thought to have been small, crocodile-like thecodonts, perhaps an animal closely related to that represented by the small skeleton (Stegomosuchus) which was found near Longmeadow, Massachusetts in 1897. Again, the evidence is not all in, but of the known Triassic land animals, Stegomosuchus-like thecodonts seem to fill the Batrachopus bill better than any others.

The "single moment" of Triassic time registered at Rocky Hill seems to show that carnivorous dinosaurs dominated the Triassic scene. Eubrontes and Anchisauripus footprints outnumber Batrachopus (which may also have been a carnivore) prints by more than three to one. In fact, there appears to be a total absence of definite herbivores. This is a most unusual community, but until a thorough analysis of the evidence preserved on this bedding plane can be made it would be premature to interpret this seemingly strange association. Nevertheless, the big question to be answered is: where were the herbivores?

I find it particularly interesting that the trackways or trails preserved at Rocky Hill seem to be completely random in orientation. This is in sharp contrast to the trackways preserved at the small park near Mt. Tom in Mt. Holyoke where (again) at least three kinds of footprints are recognizeable. The dominant kind, identified as Eubrontes, constitutes 85 percent of the identifiable trackways (as distinct from individual footprints). Of the Eubrontes trackways, 87 percent (21 out of 24) progressed in a westerly direction (trending between N 70° W and N 97° W). The three exceptional Eubrontes traverses bear in almost the opposite direction (N 65° E to N 85° E). Probability suggests that these coincident trackways were not made independently, but were made at one time by a group of animals moving together - as a "herd". Any doubts about this evidence and the "herding" behavior of these animals seems to be eliminated by the evidence of minority groups that strolled across that Mt. Holyoke scene. Two trackways have been identified as Anchisauripus and two others as probably Grallator. None of these followed the Eubrontes crowd - in fact they deviated by more than 100° from the closest Eubrontes traverse. Evidence such as

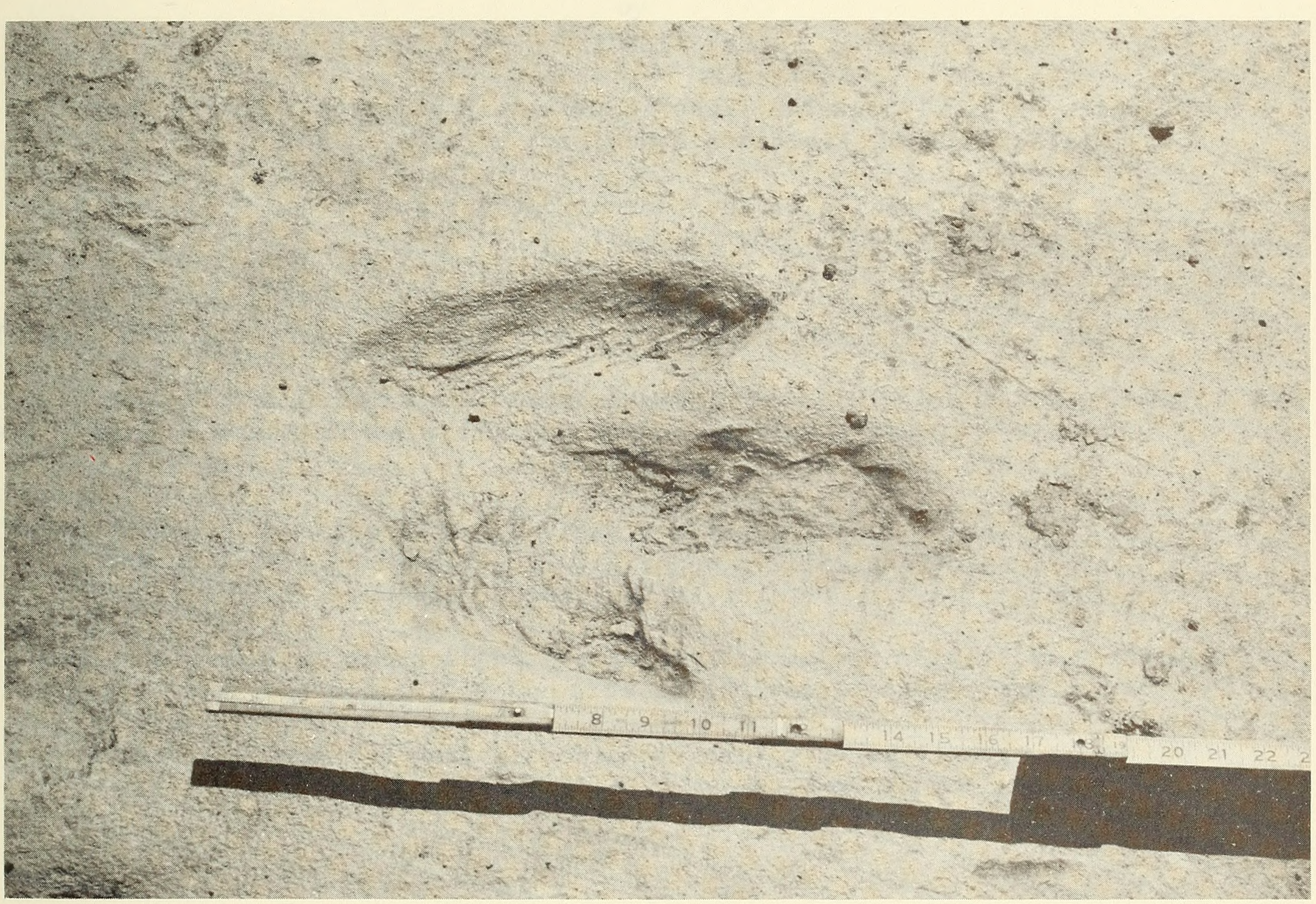

Figure 6. Eubrontes giganteus, left footprint. Rocky Hill, Connecticut.
(Photo by James F. Chipps, Jr., Conn. State Highway Dept.)

this, revealing what appears to be the herding nature of an extinct animal species, is rare indeed, but it is difficult to avoid the conclusion that at least some Triassic dinosaurs were gregarious. What additional information about the nature and habits of these animals will be revealed by the thousands of footprints at Rocky Hill?

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