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ART. XXXVIII.—*Podokesaurus* holyokensis, a New Dinosaur from the Triassic of the Connecticut Valley ;†* by MIGNON TALBOT. (With Plate IV.)

Introduction.

IN a bowlder of Triassic sandstone which the glacier carried two or three miles, possibly, and deposited not far from the site of Mount Holyoke College, the writer recently found an excellently preserved skeleton of a small dinosaur the length of whose body is about 18^{cm}. The bowlder was split along the plane in which the fossil lies and part of the bones are in one half and part in the other. These bones are hollow and the whole framework is very light and delicate.

As the fossil lies in the rock, most of the bones are in position, or nearly so, with the exception of the skull and the tail. A detached tail that probably belongs to this specimen lies a few centimeters from the rest of the skeleton and near it are three very thin bones that may belong to the skull (fig. 3, A, B, and C; Pl. IV, fig. 3). Two of these bones are bilaterally symmetrical and one of them is broadly convex with a well-defined median sulcus. They are all more or less embedded in the rock and cannot be described until the rock

* From ποδώκης = swift-footed—an epithet commonly used in speaking of Achilles.

† A paper giving a preliminary description of this fossil was read at the meeting of the Paleontological Society in Pittsburgh, in December, 1910. In that paper the conclusion reached was that the animal was a herbivorous dinosaur: but the work of developing, which is being done at Yale University, has shown that the bone that was then described as the right fibula, displaced, cannot be a fibula, and, notwithstanding its great length, it is described in this paper as the pubis, in position. The bone that was thought then to be two bones, the pubis lying over the ischium, is probably the ischium with a well-developed ridge as is seen in Compsognathus. There would be, therefore, no bone to call the postpubis and the form must be removed from the herbivorous group of dinosaurs.

FIG. 1.

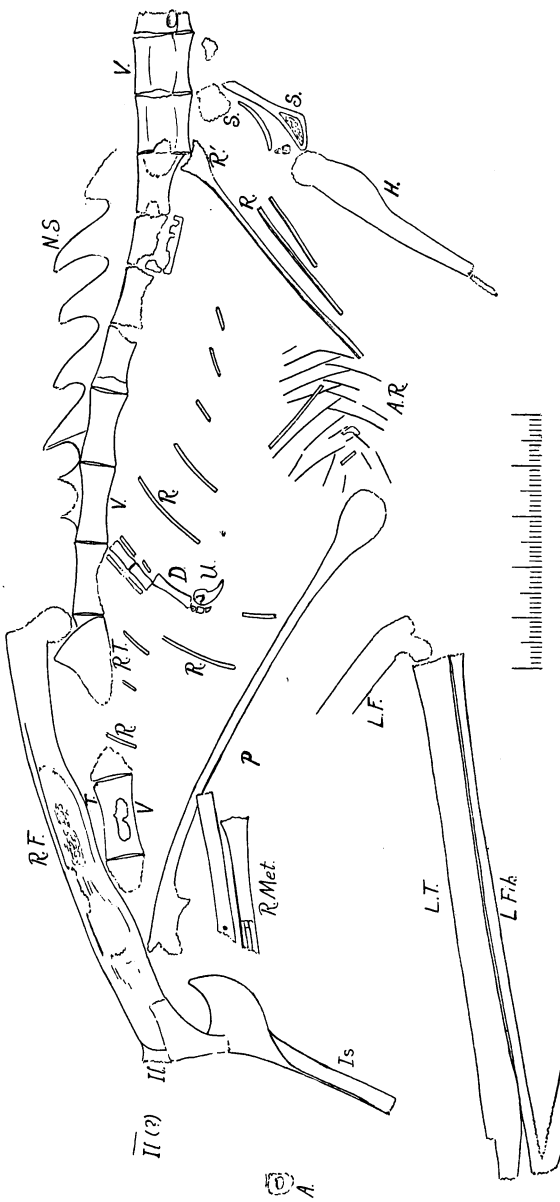

FIG. 1. Outline drawing of the fossil as it lies in the rock. ×2/3.

A. Astragalus (?). *A. R.* Abdominal ribs. *D.* Digit. *H.* Humerus. *Il.* Ilium. *Is.* Ischium. *L. F.* Left femur. *L. Fib.* Left fibula. *L. Met.* Left metatarsals. *L. T.* Left tibia. *N. S.* Neural spine. *P.* Pubis. *R.* Rib. *R. F.* Right femur. *R. Met.* Right metatarsals. *R. T.* Right tibia. *S.* Shoulder elements. *T.* Fourth trochanter. *U.* Ungual. *V.* Vertebra.

is removed. The other bones are better exposed and will be described below.

Description.

In the description which follows these features are to be noted: Light construction—hollow bones; slender, straight femur; position of fourth trochanter; position of fibula, lying close to the tibia; great length of tibia and metatarsals; small humerus; narrow shaft of ischium; great length of pubis; length of vertebræ.

Forelimb.—The humerus (fig. 1, H.)* is a very delicately shaped bone, 42^{mm} long (not quite half the length of the femur), slender and well rounded, with high radial crest. The proximal end shows a slight constriction above the crest and below the bone tapers gradually to a diameter of 3^{mm} at the distal end. Measured through the crest it is 8^{mm}. There is a trace of the impression of the radius or ulna just beyond the distal end.

In the scapular region is a broad, flat bone, lying vertically in the rock, but twisted on its long axis at a right angle, midway of its length (fig. 1, S.). This bone has a length, as shown, of 20^{mm} and a width of at least 3^{mm}. Lying near its proximal end is another flat bone, 8^{mm} long by 5^{mm} wide. These may be three separate bones, more or less firmly united in the living animal. Further development is necessary, however, to bring out their outlines and their relation to each other.

Hindlimb.—The femur (fig. 1, R. F. and L. F.) is slender and nearly straight with thin walls. The bone is expanded on the back side at the distal end. The length is 86^{mm} and the diameter, just distalwards from the fourth trochanter, is 6·5^{mm}. The fourth trochanter (fig. 1, T.) is 18^{mm} long and about 2^{mm} high and is situated just beyond the middle of the shaft, toward the distal end.

Only the proximal end of the right tibia (fig. 1, R. T.) is exposed and there the bone is well rounded. This, however, may be only a small part of the proximal end, as the bone is embedded in the rock. The left tibia (fig. 1, L. T.) is split lengthwise, part of the bone lying in each half of the bowlder. It is an almost straight, narrow shaft with the surface lying uppermost bent slightly at the proximal end, due, probably, to the expansion of the bone. In the position in which it lies, the bone is of nearly the same diameter throughout, about 7^{mm}. Its length is 104^{mm}. Lying close against the tibia and of almost equal length is the extremely thin fibula (fig. 1, L. Fib.).

There is a small, convex bone, 4^{mm} by 6^{mm}, lying where the

* The first four text-figures have been drawn by Miss Clara Gould Mark of Mount Holyoke College. For the privilege of using the restorations of Professor Marsh I am indebted to the editor of this Journal. The photographs were taken by Mr. Asa S. Kinney of Mount Holyoke College.

right tibia and metatarsals should meet, that may be the astragalus (fig. 1, A.). It shows no sign of an ascending process.

Two of the right metatarsals (fig. 1, R. Met.) lie in position. Their diameter is 2·5^{mm} and 3·5^{mm}, respectively, along the shaft, but at the distal end there is an expansion to a diameter of 5^{mm}. In position, at the distal end of the left tibia there is one metatarsal (fig. 1, L. Met.) slightly curved and 65^{mm} long. Alongside are traces of a second. One of the digits (fig. 1, D.), whose divisions are indistinctly shown, lies between two ribs not far from the right metatarsals. It is 20^{mm} long and 1·5^{mm} in diameter and is terminated by an ungual 7^{mm} long. Cross sections of two bones near this one look like unguals.

Pelvis.—The pelvic bones are partly covered by the right femur and their outline is not distinct. What is probably the

FIG. 2.

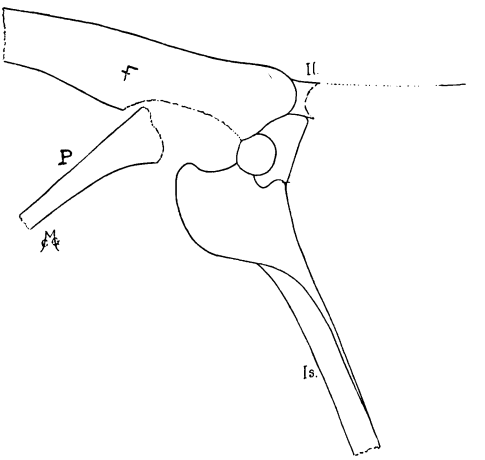

FIG. 2. Pelvic bones. ×1.

F. Femur. *Il.* Ilium. *Is.* Ischium. *P.* Pubis.

pubis (fig. 1 and fig. 2, P.) is a remarkably long, thin bone, 95^{mm} long, expanded at the distal end. The bone seems to be in position and makes an angle of about 40° with the line of the vertebral column. Its length is comparable with that of a new, undescribed form from northern Württemberg.

The ischium (Pl. IV, fig. 2; fig. 1 and fig. 2, Is.) is well rounded, anteriorly, and has a shaft 4^{mm} wide of which a length of 30^{mm} is exposed.* The distal end is embedded in the rock.

* The illustrations seem to indicate the presence of two bones but this may be due to the presence of a ridge on the ischium, as is seen in Compsognathus.

The contact with the ilium and the acetabular edge is obscurely visible.

There is a bone running posteriorly from the head of the right femur which may be the posterior process of the ilium (fig. 1 and fig. 2, Il.), the anterior process being covered by the femur. This posterior extension can be traced indistinctly for 27^{mm} and either points upward or continues the line of the posterior part of the vertebral column.

Vertebræ.—Of the vertebræ there are visible seventeen presacral (fig. 1, V.) and thirteen caudal (fig. 3, V.), all very light

FIG. 3.

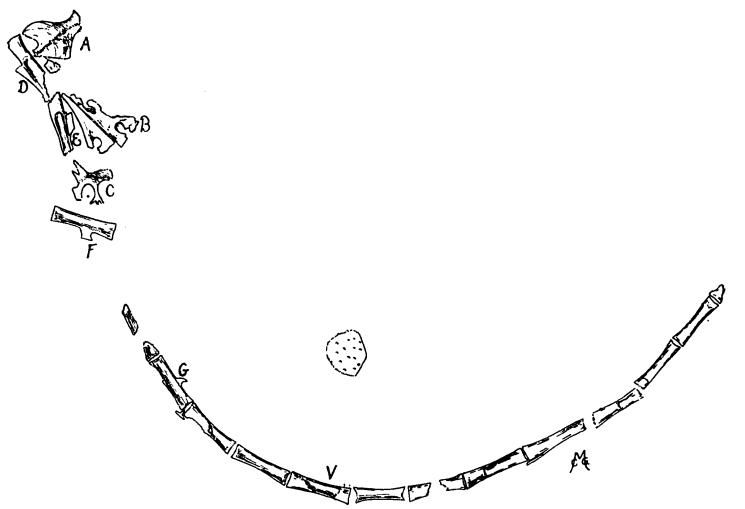

FIG. 3. Caudal vertebræ and skull bones (?). $\times \frac{1}{2}$.

A, B, C. Bones of the skull (?). *D, E, F, G, V.* Caudal vertebræ.

and hollow, and some, at least, slightly concave at each end. The presacral vertebræ are slender, the measurements for the sixth presacral being 4^{mm} through the middle of the centrum, 6^{mm} at the ends and 15^{mm} from end to end. A strong, gracefully curved neural spine (fig. 1, N. S.) rises from the vertebræ in the dorsal region, about 10^{mm} high and 12^{mm} long at the base. The first two or three presacrals are a little larger than the others and those at the anterior end of the column, much stronger. One of the latter measures 10^{mm} at the end and the diameter through the middle of the centrum is only a little less. They are not so long, however, measuring only from 12^{mm} to 13^{mm}. One of these vertebræ is shown in cross section at a thin edge of the rock and has a transverse diameter through

the cavity of the centrum of 4^{mm} while the height of the cavity is $5{\cdot}5^{mm}$ (fig. 4).

The caudal vertebræ are only a little expanded at the ends and are very slender throughout their length. A typical one is 17^{mm} long with a diameter of 4^{mm} at the ends. The neural spines, if such they are (fig. 3, D.–G.), are of different shapes. These caudal vertebræ are so nearly of a size, one with another, that there is no apparent tapering of the series and it is not clear which is the proximal end of the tail nor is it possible, as yet, to estimate its length.

FIG. 4.

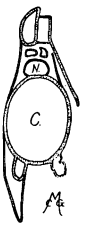

FIG. 4. Cross section of cervical vertebra showing hollow construction. ×2.
C. Cavity of centrum. *N.* Neural canal.

Ribs.—Quite a number of ribs (fig. 1, R.) are visible, all very slender and hollow, but the proximal end is not exposed save in one instance where the bone is so broken that the outline is not distinct. Near this proximal end, however, the bone is somewhat concave and expanded as if it might be bifurcate (fig. 1, R′). The largest rib uncovered is 52^{mm} long and 2^{mm} wide toward the proximal end, while in no place does the thickness seem to be more than 1^{mm}. The most anterior of the cervical vertebræ preserved have long ribs. These are on another piece of the bowlder and are not figured.

Just anterior to the distal end of the pubis there is a small cluster of gently curved abdominal ribs (fig. 1, A. R.), exceedingly slender and dove-tailed as they lie in the rock, the position due, probably, to slipping. This mass of interlacing ribs covers a space of 40^{mm} by 23^{mm}. There are at least eleven of these ribs on each side of the median line, the largest of which is 18^{mm} long and so small in diameter that the bone looks like a mere thread in the rock. Slender as are these ribs, they seem to be hollow.

Sternal element (?).—In the center of this mass of abdominal ribs is a small body that responds to dilute hydrochloric acid, as do all of the bones. The part exposed measures 5^{mm} by 3^{mm}. This may be one of the sternal elements displaced.

Gastrolith.—Lying 10^{mm} away, and still among these ribs, is a small piece of quartz, a flat, well-rounded pebble, 1^{mm} thick and 10^{mm} long. The width exposed is 4^{mm}, but more of the pebble is embedded in the rock. There are no other pieces of quartz larger than a grain of sand visible in the bowlder, and considering this fact, considering, also, its smooth, polished surface* and its position, the writer concludes that this must

* Dinosaurian Gastroliths, G. R. Wieland, Science N. S., xxiii, pp. 819–821.

be a gastrolith. This would seemingly be the first record of gastroliths found with carnivorous dinosaurian remains.

Comparison with other forms.

Herbivorous dinosaurs.—Compared with *Nanosaurus agilis* Marsh, the oldest known predentate dinosaur, the following points may be noted:* *Points of similarity*—The femur is shorter than the tibia, the ribs are very delicate, and the posterior extension of the ilium seems to have the same position. *Points of dissimilarity*—In this form the femur is more slender and is nearly straight, while in *Nanosaurus* it is distinctly curved. In this form, too, the fourth trochanter is much nearer the distal end of the femur, the metatarsals are more slender and probably longer, the humerus is relatively much smaller, the shaft of the ischium is narrower, the pubis has a long anterior extension, and there is no postpubis.

In *Laosaurus consors* Marsh,† from the Jurassic, the femur is much curved and is more nearly equal in length to the tibia, while the fourth trochanter is far up toward the proximal end; the fibula is more bent, curving away from the tibia; the metatarsals are very much shorter; the prepubis is short and pointed; and a postpubis is present. *Laosaurus* has a short humerus as this form has but the shape is not the same.

Hypsilophodon foxii Huxley (fig. 5), of the Wealden, England. Here we notice that the main points of difference are in the length and position of the pubis, and the presence of a postpubis in *Hypsilophodon*. In *Hypsilophodon* the femur is curved, but the fourth trochanter is situated more nearly as this one is, toward the distal end; the humerus is stouter and larger in every way with the radial crest much farther from the proximal end; the metatarsals are much shorter; the ribs are very much stronger; the neural spines are of an entirely different shape.

Carnivorous dinosaurs.—Anchisaurus colurus Marsh,‡ a very slender, long-limbed carnivore from the same Connecticut valley Triassic, with which this form seems to compare quite closely in general outline, shows the following differences. There is a decided difference in the relative lengths of the femur and tibia, the femur of the large form being much longer than the tibia. Marsh points out that the long femur is found in the larger animals of both carnivorous and herbivorous types, while the smaller birdlike forms of both types have the tibia longer than the femur.§ This small form certainly

* Neubeschreibung des Originals von Nanosaurus agilis Marsh, F. von Huene and R. S. Lull, fig. 1, p. 135.

† Dinosaurs of North America, O. C. Marsh, pl. LVII.

‡ Ibid., pl. IV.

§ Ibid., p. 201.

FIG. 5.

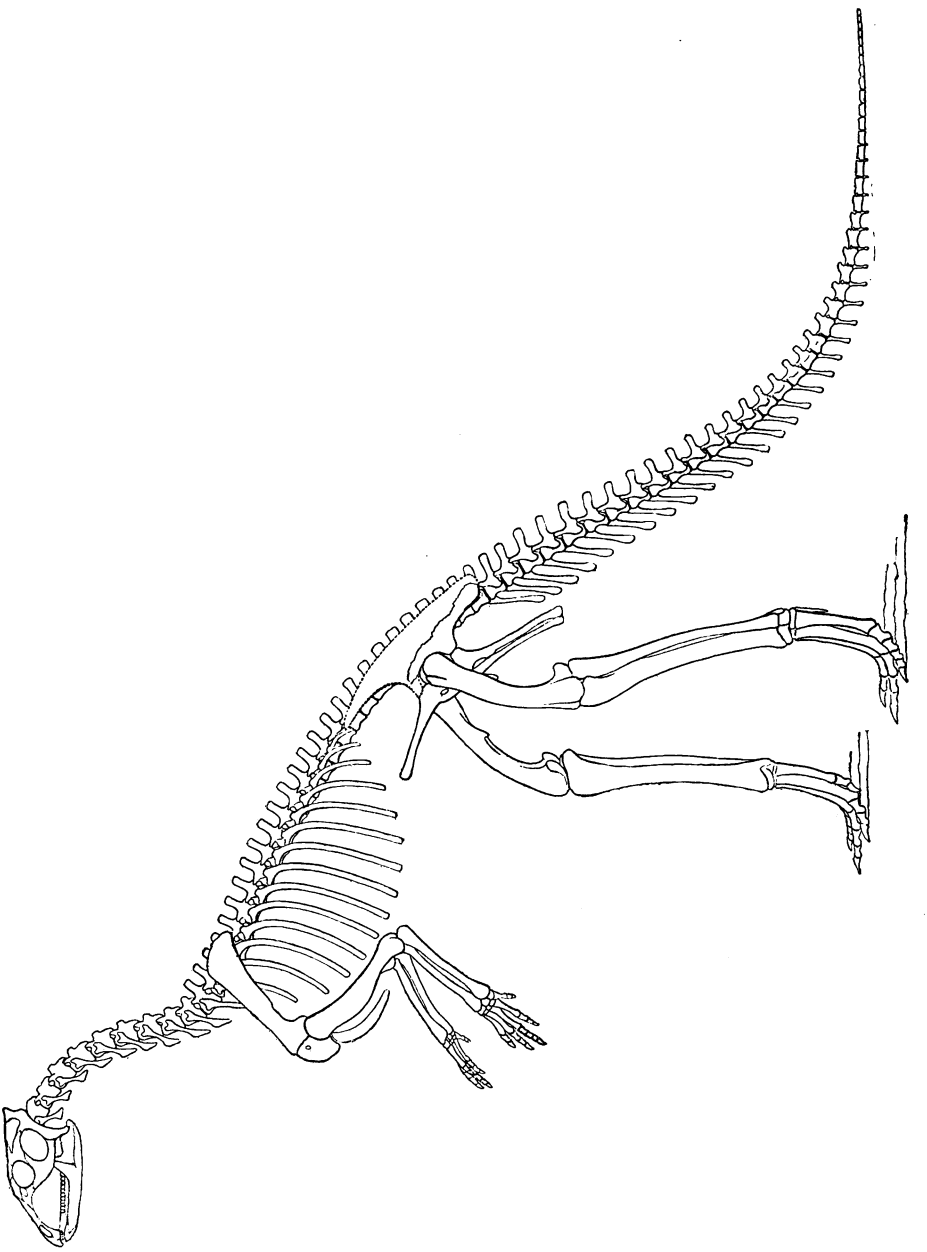

FIG. 5. Restoration of *Hypsilophodon foxii* Huxley, after Marsh. ×1/8 natural size.

helps to confirm his observation. In *Anchisaurus*, the femur is much bent and the fourth trochanter is high up toward the proximal end ; and all the limb bones are much stronger. The pubis of *Anchisaurus* is shorter, and runs at almost a right angle to the vertebral column ; nor is it expanded at its distal end, as it is in this form. On the other hand, there is a general similarity in the size of the corresponding vertebræ, though those of the caudal region of *Anchisaurus* are not quite so long and slender.

Compsognathus longipes Wagner (fig. 6), from the Jurassic of Bavaria, corresponds quite closely with this form in length and general proportions of the limbs, in the shape of some of the neural spines, especially those just anterior to the scapular region, and in the general shape of the ischium. The pubis of *Compsognathus* is much shorter, proportionally, however, makes a larger angle with the vertebral column, and is much more expanded at its distal end. The shaft of the ischium is not so slender nor so uniform in width.

Classification.

No attempt at a definite placing of this fossil will be made in this paper, but certain conclusions reached by the foregoing study will be stated. The fossil is interpreted as that of a carnivorous dinosaur because of the length, shape, and position of the pubis and the absence of a postpubis. Since no jaw has been found and there is no proof of the presence or absence of an ascending process from the astragalus, the determination of its position among the dinosaurs depends on the character of the pubis and the presence or absence of a postpubis. The position and length of the pubis are more nearly like those of the carnivores than those of the herbivores, and there seems to be no postpubis. The ischium is shaped somewhat like the bone in *Scelidosaurus harrisoni* Owen, that von Huene describes as the ischium, with a query, however, stating that it may be the pubis, but not accepting that interpretation because he can find no obturator foramen.*

The short, slender humerus and the long, straight hind-limb bones, together with the well-developed fourth trochanter, are indicative of bipedalism. The length of the tibia, much greater than that of the femur, the extreme length of the metatarsals, over half that of the tibia, and the very light construction of the skeleton, indicate rapid locomotion, which Lull uses as an indication of adaptation to climatic conditions, arguing that this animal must have been able to travel fast and

* Ueber die Dinosaurier der Aussereuropæischen Trias, F. von Huene, p. 57.

FIG. 6.

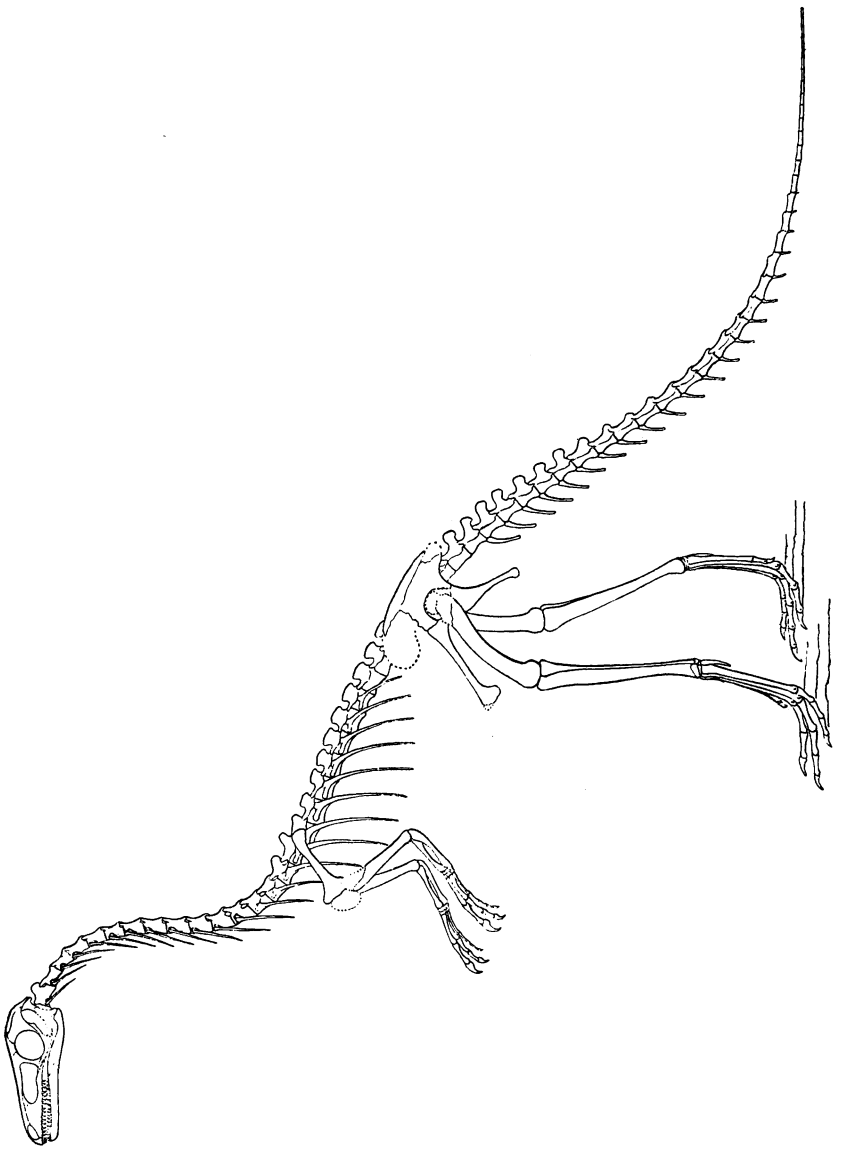

FIG. 6. Restoration of *Compsognathus longipes* Wagner, after Marsh. × 1/4 natural size.

far for water in a semi-arid climate. In support of this interpretation, also, may be added Barrell's suggestion that the rock in which the fossil is embedded indicates deposition on a flood-plain in a semi-arid region. It is significant that many of these Connecticut valley sandstones that have dinosaur footprints have also raindrop impressions.

Through the courtesy of Professor Schuchert the specimen has been sent to the Peabody Museum of Yale University for development, where further study will be given it by Professor Lull, to whom my thanks are due for many suggestions in regard to the interpretation of this fossil.

Mount Holyoke College, April, 1911.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 1. *Podokesaurus holyokensis.* ×2/3.
FIG. 2. Pelvic bones. ×3/2.
FIG. 3. Skull bones (?). ×4/3.