

ART. XLVIII.—*The Fossil Frogs of North America*; by
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THE present review of the fossil frogs of North America is intended to give all the available data regarding the geological and geographical distribution of the Salientia in this continent.

Frogs are of rare occurrence in all known geological formations and our knowledge of their ancestry and origin is very uncertain. It is my intention to indicate, in this review, the possible presence of the Salientia in the Carboniferous of North America and the possible derivation of the salientian Amphibia from other of the Carboniferous land vertebrates. It is the further purpose of this paper to call attention to the discovery of true toads in the Pliocene of Kansas. This announcement is based on remains collected by Mr. J. B. Hatcher in August, September, October of 1884 near Long Island, Kansas. The specimens have recently been sent me for study through the kindness of Mr. Charles Gilmore of the United States National Museum, to which institution the specimens belong. It is the further purpose of this paper to publish figures of the only known American Jurassic Frog, the *Eobatrachus agilis* of Marsh. Professor Marsh has evidently intended to describe and illustrate the *Eobatrachus* fully, for these drawings were found among his effects in the National Museum. They are here published as he left them.

Remains of Salientia have been found in the following geological formations: Carboniferous (Middle Pennsylvanian) (?); Jurassic (Comanchean) Como Beds; Upper Miocene (Pliocene); Pleistocene.

PELION LYELLI Wyman.

This Carboniferous species has been very thoroughly treated in the writer's forthcoming monograph of Carboniferous Amphibia and a detailed description in this place is not needed. The length of the vertebral column was probably considerable, possessing an estimated number of 22 or 23 vertebræ. The vertebral segments of all modern and fossil Salientia is nine, but it is well known that the urostyle is a series of coössified vertebræ. This anyone may demonstrate to his satisfaction by the study of a tadpole cleared by the potash method as outlined by Professor Mall* and the writer.† The ossifications in the urostyle are definitely segmental and young stages show perichondral ossifications similar in many respects to the ossification of other vertebral centers. The whole subject, however, needs careful study, and these observations, while I

* Amer. Journ. Anat., 1906.

† Amer. Journ. Anat., 1908.

believe them accurate so far as they go, must be confirmed and extended. If the metameric arrangements of the primitive ossification rings in the urostyle indicate that the Salientia came from ancestors with long vertebral columns, then *Pelion lyelli* from the Carboniferous of Linton, Ohio, may well stand in such an ancestral relation. The species is, however, very little known. The remains were the first discovered in the Linton beds of Ohio and in spite of careful search and among the hundreds of other specimens taken from this interesting locality, there has not turned up a single fragment that resembles *Pelion lyelli*. Whether the Linton fauna will be rediscovered remains to be seen.

The remains of *Pelion lyelli* consist of the impression of the ventral surface of the skull and mandible highly carbonized and the structures obscured; a portion of the vertebral column; the major portion of the pectoral girdle and arms; remains of one leg; and an indication of the pelvis. So far as the form of these elements go they are all strikingly salientian, as was noticed by Wyman and Cope and to which attention has been several times called.

It would be too bold a statement to say that *Pelion* is an ancestral salientian, for our knowledge is such that we can say but little more than that *Pelion* looks like a frog with a characteristic long leg and a long back.

The specimen of *Pelion lyelli* is in the American Museum of Natural History.

The history of the Salientia geologically is an interrupted one and if *Pelion* is a frog then the next indication we find of frogs in America is in the Upper Jurassic (Comanchean), in the Como Beds of Wyoming first mentioned by Professor Marsh in 1887 and more fully described by the writer in 1912.

EOBATRACHUS AGILIS Marsh.

Marsh, this Journal (3), xxxiii, p. 328, 1887.

Marsh, Proc. Brit. Assoc. Science, Aberdeen Meeting, 1885, p. 1033.

Marsh, Monograph U. S. G. S., xxvii, p. 508, 1897.

Moodie, this Journal, xxxiv, p. 286, 1912.

The specimens of *Eobatrachus agilis* Marsh seem to indicate a bufonid nature for the species. In fact I think we would be safe in locating the species in the family Bufonidæ. The reasons for placing the species in this family are chiefly on account of the well-developed condition of the lower end of the humerus (fig. 1, *a*; 2, *d*), and its apparently calcified condition. The ulno-radial articular surface of the humerus is certainly not the same in *Eobatrachus agilis* as it is in *Rana pipiens* or *Rana catesbiana*, and it does resemble the epiphysal structures of calcified cartilage of some of the toads.

The specimens represent two or more individuals. At least there are two different grades of sizes. All of the specimens are from quarry 9 of the Como Bluff in Wyoming; and are now preserved in the Yale University Museum.

The *humerus* (No. 1862, Yale University Museum) of what I suppose to be the typical specimen is represented by the lower end only, this portion measuring 6^{mm} in length, by 2^{mm} in distal width, by slightly more than half a millimeter in shaft diameter. The well-developed characters of the bone indicate a bufonid nature for the species. The ulno-radial articular surfaces are as distinctly marked as in all modern Salientia with which I am acquainted. The ball is apparently capped with calcified cartilage. Above the ball is a distinct pit for muscular attachment, precisely as in modern frogs. The shaft is quite slender and nearly circular (fig. 1, *a*).

The *ilium* (No. 1568 Yale University Museum) is quite peculiar and will possibly be sufficiently characteristic to sustain the validity of Professor Marsh's genus, *Eobatrachus*. The element is of the right side. It measures 10^{mm} in greatest length, by 3^{mm} in greatest width, by 2^{mm} in greatest thickness on the articular surface. The element is a slender rod, like the modern salientian ilium, with the anterior end greatly narrowed and pointed; the pointed portion occupying one and one-half millimeters. The shaft of the ilium is flattened laterally. It expands in width from a little less than one-half a millimeter to slightly more than three millimeters. The articular surface is marked by four pits which are the surfaces of the synchondrosteal union of the halves of the pelvis. The element is greatly thickened posteriorly, with a slightly developed, posterior dorsal crest (fig. 1, *c*).

The *femur* (No. 1862 Yale University Museum) is quite distinctly amphibian of the salientian type. It is a slender rod of bone from which the epiphyses have been lost, leaving in their place pits occupying the ends of the bone; indicating the slight development of the endochondral ossification, as in all Amphibia. The lower end of the femur is divided into two surfaces by an imperfect partition, as in most modern frogs. The upper end is peculiar in having a well-developed crest which, in life, was undoubtedly capped by a large amount of cartilage. In the fossil state it has been preserved as a spine. The femur measures 12^{mm} in length, by 3^{mm} in distal width, by 1^{mm} in diameter of shaft, by 2.5^{mm} in proximal width.

The *tibio-fibula* (No. 1394 Yale University Museum) is represented by a portion of the lower end including 8^{mm} of the element. Its characters are so clearly those of the modern Salientia that a description is hardly necessary. The lower end is divided by grooves one on either side, indicating the previous

separation of the tibial and fibular elements, thus plainly showing that the frogs have had a long pre-Jurassic history (fig. 1, *b*).

FIG. 1.

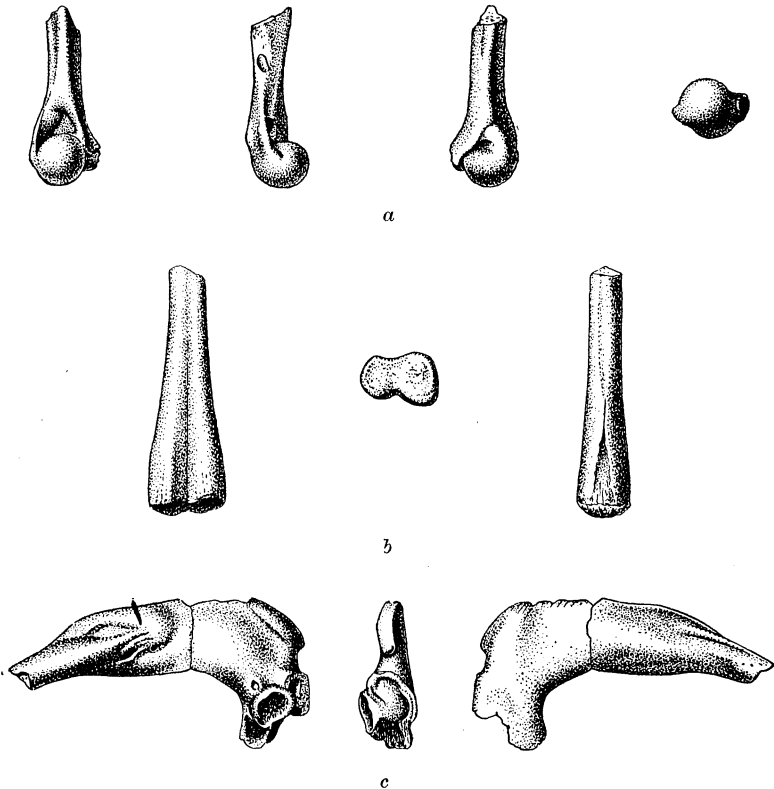


FIG. 1. Professor Marsh's drawings of *Eobatrachus agilis* from the Jurassic of Wyoming.

- a.* From Can 4. Four views of the humerus (1862) collected in the Como beds. $\times 4$.
- b.* Three views of the tibio-fibula (No. 1394) from tray 13 collected in the Como beds. $\times 4$.
- c.* Three views of the ilium—the inner, the posterior and the outer. (No. 1568) from Can 1. $\times 4$.

Another *humerus* (No. 1863 Yale University Museum) is similar to the one already described, although smaller.

The Jurassic frog thus indicated was an animal about the size of *Bufo debilis* Girard of western Kansas and Texas. In

the writer's previous paper the statement was made that *Eobatrachus* was *the oldest known frog*. At the time I was not aware of the species *Paleobatrachus gaudryi* described by Vidal in 1902 from the Kimmeridge of Spain. Doctor Abel called my attention to this species and kindly furnished

FIG. 2.

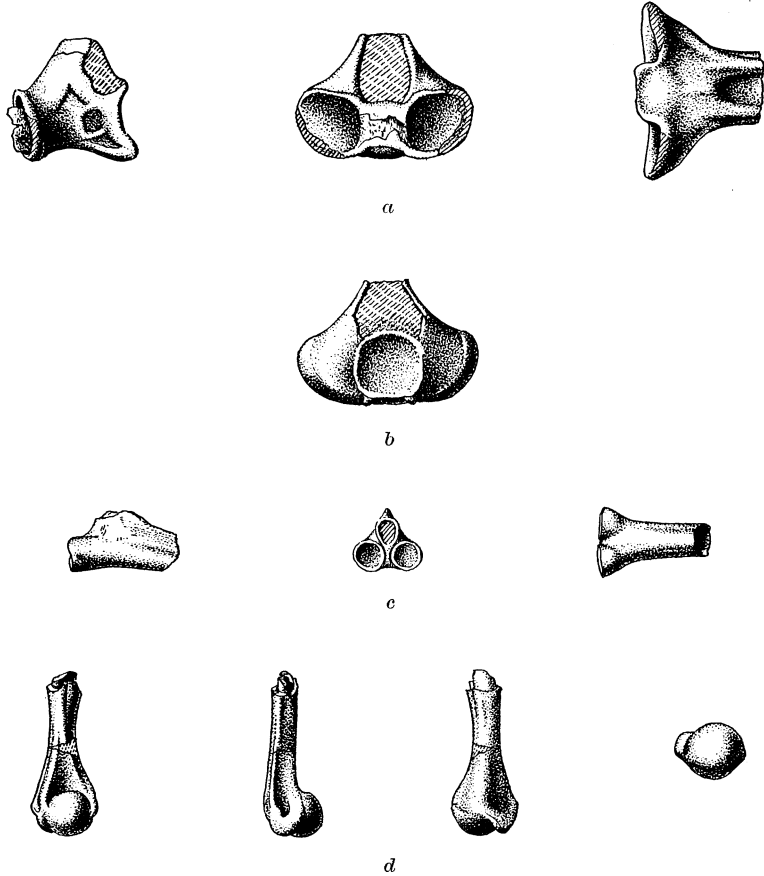


FIG. 2, a. Three views of vertebra (No. 1763), Can 42. $\times 4$.
b. Posterior view of vertebra (No. 1763), Can 42. $\times 4$.
c. Lateral, posterior and dorsal views of proximal portion of urostyle (No. 1687), Can 2. $\times 4$.
d. Four views of humerus (No. 1863). $\times 4$.

the references given below.* The only question now as to the relative ages of the species is that of determining the relative ages of the Kimmeridge and Morrison and of the two the Kimmeridgian is undoubtedly the older.

Bufo sp.

The deposit near Long Island, Kansas, had been known for many years as a deposit famous for the production of rhinoceros and other mammalian forms. From these deposits also come the interesting Euphorbia (*Tithymalus willistoni* Cockerell). The frog remains recently sent me by the United States National Museum were mingled with the Euphorbia seeds, with fragments of small rodents, with small undetermined lizard bones in such a way that they must have been either blown or washed into the same pocket. I have separated out the skeletal elements of several individuals of toads. The elements are chiefly limb bones, vertebræ, urostyles, ilia with scarcely a fragment that can be identified as skull. The humeri especially show well-developed and well-preserved epiphyses which are calcified and are occasionally firmly attached to the cylindrical shaft. In one humerus there is a well-developed deltoid crest which was probably capped by cartilage, this in turn being confluent with the articular cartilage of the head of the humerus. I have had no means of identifying the specimens specifically and I cannot be positive the genus is correct. This must be done by someone connected with an institution containing extensive collections of skeletal elements of the salientian Amphibia. It is not thought desirable to figure the remains, this being left to the one who will discuss the taxonomy of the creatures involved. There is nothing among them which is not found in the modern bufonid.

In the Pleistocene of Pennsylvania and of Arkansas Wheatly and Brown† have found remains which they have regarded as *Rana*, but the elements preserved are very scanty. Professor Lull also reports the finding of remains of Salientia in the Pleistocene deposits at the head of Tule Canyon, Briscoe County, Texas.

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* In case others may not have seen the following reference I give it here in full:

Louis Mariano Vidal: Sobre la presencia del tramo Kimeridgense en el Montseih y hallazgo de un Batracio en sus hiladas.

Sur le presence de l'étage Kimeridgien au Montseih (Province de Lerida. Espagne), et decouverte d'un Batracien dans ces assises.—Memorias Real Academ. Cienc. y Artes de Barcelona, iv, 1902, No. 18. (The frog is named *Palæobatrachus gaudryi*, Vidal, 1902).

† Mem. Amer. Mus. Natl. Hist. 1.