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A New Frog from an Eocene Oil-Well Core in Nevada

BY MAX K. HECHT

INTRODUCTION

The fossil history of the Anura is not adequate at the present time for a complete reëvaluation of the zoogeography, phylogeny, and systematic relationships of this group, but the fossil record is better than most neozoologists would admit. Certainly our identifications of fossil material can be only tentative so long as osteological collections and knowledge of Recent material are inadequate. There is a desperate need for comparative osteological studies both of families and within families. The batrachologist studying mid-Tertiary and earlier deposits cannot make the tacit suppositions (which are questionably valid) of students of the Pleistocene that the fauna in a North American deposit contains only North American elements or, for that matter, only New World forms. Comparisons must be made on a global scale, or the identification will be even more tenuous than is necessitated by the limitation of our collections and knowledge. Lastly, we must recognize that frog classification, on the generic and familial level and above, is at best an artificial arrangement and not a natural classification. Despite all these considerations, I attempt here to discuss the status of a poorly preserved frog, because it may shed some light on a poorly understood situation.

The specimens available for study were brought to the American Museum of Natural History by Dr. Harold Kellogg, who first saw them during his studies on his thesis area in the southern Egan Range, Nevada. Mr. W. L. Smith of the Shell Oil Company made the first two specimens available to the American Museum of Natural History. One

of these specimens is the lower half of the species described in the present paper and therefore part of the holotype. The upper half was placed in the Standard Oil of California collections but was later added to the American Museum collections in order that this study might be complete. Both upper and lower halves were given a single number in the American Museum catalogue (A.M.N.H. No. 7602). The second specimen (A.M.N.H. No. 7603) contributed to the American Museum collections will be discussed in a later study.

Little is actually known of the anuran fauna of the Eocene. Noble (1930) described the genus *Indobatrachus* from the Intertrappean beds of Bombay, which today is considered to be of leptodactylid affinity. Weitzel (1938) described a pelobatid, *Propelodytes*, from the mid-Eocene of Germany. Kuhn (1941) described many new forms from the Geiseltal (mid-Eocene) of Germany, such as a paleobatrachid (*Halleobatrachus*), a brachycephalid (*Quinquevertebron*), bufonids (*Bufo* and *Eobufo*), a ranid (*Rana*), pelobatids (*Palaeopelobates*, *Archaeopelobates*, *Archaeopelobets*, *Amphignathodontoides*, *Pelobatinopsis*), and two other genera of unknown relationship (*Opisthocoelellus* and *Opisthocoelorum*). Schaeffer (1949) described one genus, *Eophractus*, of leptodactylid or hylid affinities from the Eocene of Patagonia. Hecht (1959) reported a rhinophrynid frog, *Eorhinophrynus*, and a megophryine pelobatid from the middle Eocene of Wyoming.

At present two specimens (A.M.N.H. Nos. 7602, 7603) from an Eocene well core are available for study. A third specimen, probably from the same formation, is in the Los Angeles County Museum collections and is being studied by Jay Savage. Of the two specimens available the best specimen (A.M.N.H. No. 7602) appeared almost impossible to interpret (figs. 1 and 2). Its present interpretation is a result of the efforts of Mr. Chester Tarka who called attention to the use of ultraviolet radiation (3660 Å.) to excite fluorescence of the organic material in the core. When the fluorescent specimen was photographed it was possible to interpret this fossil find (figs. 3, 5, and 7) as a new leptodactylid frog from the Eocene of Nevada.

SYSTEMATIC DESCRIPTION

CLASS AMPHIBIA

SUPERORDER SALIENTIA

ORDER ANURA

SUBORDER NEOBATRACHIA

FAMILY LEPTODACTYLIDAE

*EO*RUBETA, NEW GENUS

GENOTYPE: *Eorubeta nevadensis*, new species.

GENERIC DIAGNOSIS: An anuran of leptodactylid affinity with a toothed maxilla, seven presacral vertebrae, the sacral diapophysis expanded distally, and with the transverse process of the dorsal vertebrae of equal or subequal width and flattened distally.

***Eorubeta nevadensis*, new species**

TYPE: A.M.N.H. No. 7602, crushed skeleton on two faces of a parted oil-well core.

HORIZON AND TYPE LOCALITY: Member C (Kellogg, MS), Sheep Pass formation, early Eocene, White Pine County, Nevada. Received from Core 8; 3907 to 3964 feet in depth, Standard Oil Company of California Line Unit No. 1, northwest corner of northwest sect. 19, T. 10 N., R. 62 E.

SPECIFIC DIAGNOSIS: Same as for the genus.

DESCRIPTION OF TYPE: A badly crushed frog represented as an organic imprint in a well core on two different fragments.

Dorsal imprint: The skull is badly crushed, with its most anterior region cut by the end of the well core. There are remnants of the maxilla, frontoparietal, nasal (?), pterygoid (?), squamosal, quadratojugal (?), prootic, and the occipital region. The occipital region is well preserved and has a distinct, crushed, vertebra-like appearance. Two occipital condyles and a foramen magnum can be identified. Posterior to the skull there are clearly present seven vertebrae with large transverse processes and remnants of an atlas. The transverse processes are equal or subequal in width and flattened and dilated at their tips. The sacral diapophyses are large and expanded at the distal end with a subtriangular form. On the posterior surface of the sacral centrum are two small mounds which probably represent the double sacral condyle. A urostyle is present and well developed. On the left side a piece of what is probably limb bone or perhaps ilium lies across the base of the transverse processes. The posterior border of this unidentifiable piece lies at the anterior border of the base of the sacral diapophysis. On the right side a complete ilium can be seen, with its anterior portion lying at the ends of the last three transverse processes and the sacral diapophysis. At the base of the ilium there is a small gap which may represent the acetabulum and pubis, and extending towards the left is another large, curved ilium or possibly a femur. This left ilium crosses over the posterior border of the urostyle. Behind the left ilium and the urostyle is another limb bone, probably a tibio-fibula.

At the upper left side of the specimen below the skull is a large triangular plaque which represents the scapula and perhaps scattered remnants of the pectoral girdle.

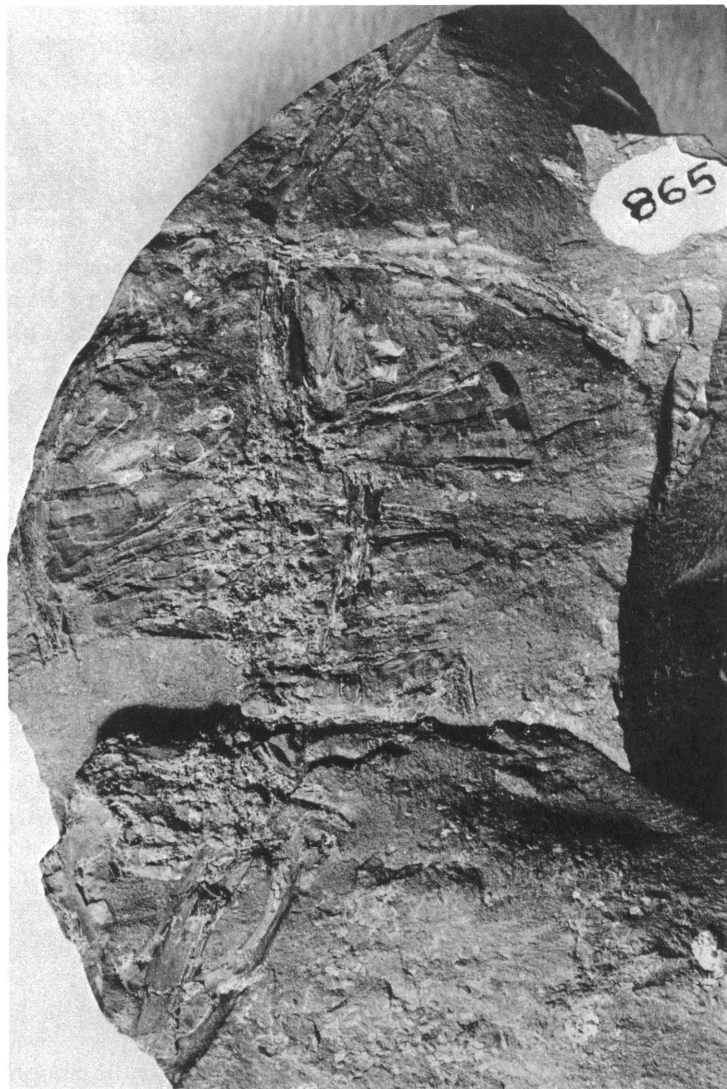


FIG. 1. Dorsal section of *Eorubeta nevadensis* (A.M.N.H. No. 7602) under normal light. $\times 1.7$.

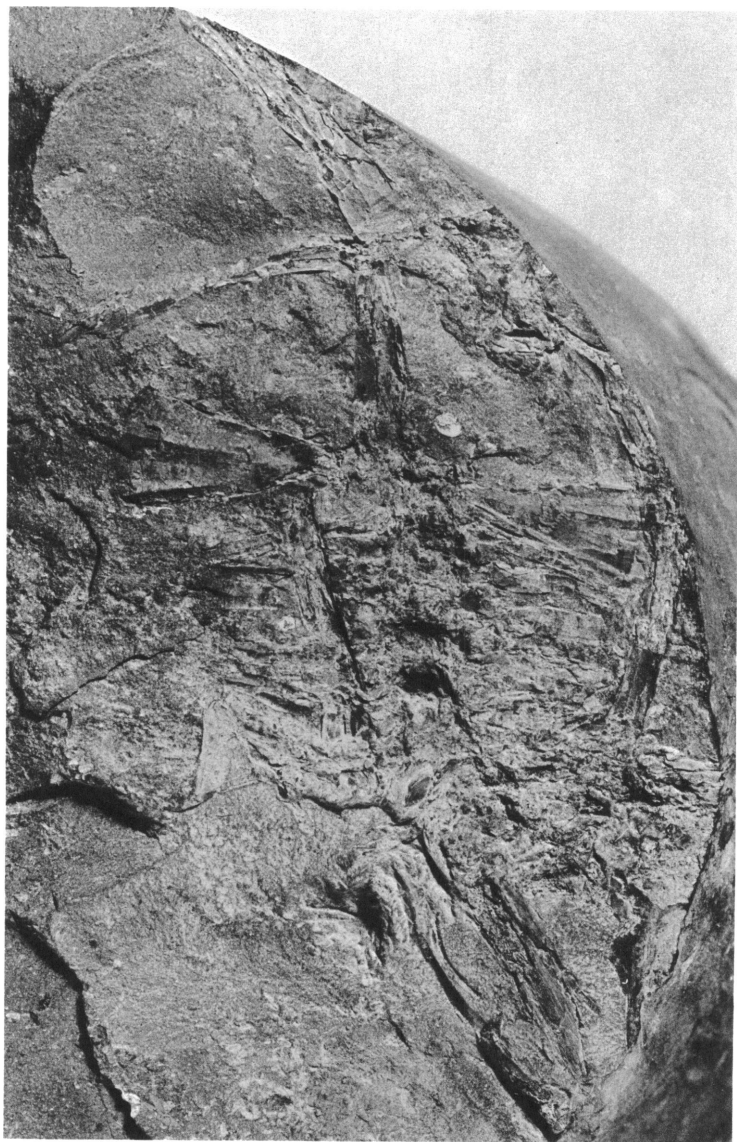


FIG. 2. Ventral section of *Eorubeta nevadensis* (A.M.N.H. No. 7602) under normal light. $\times 1.7$.

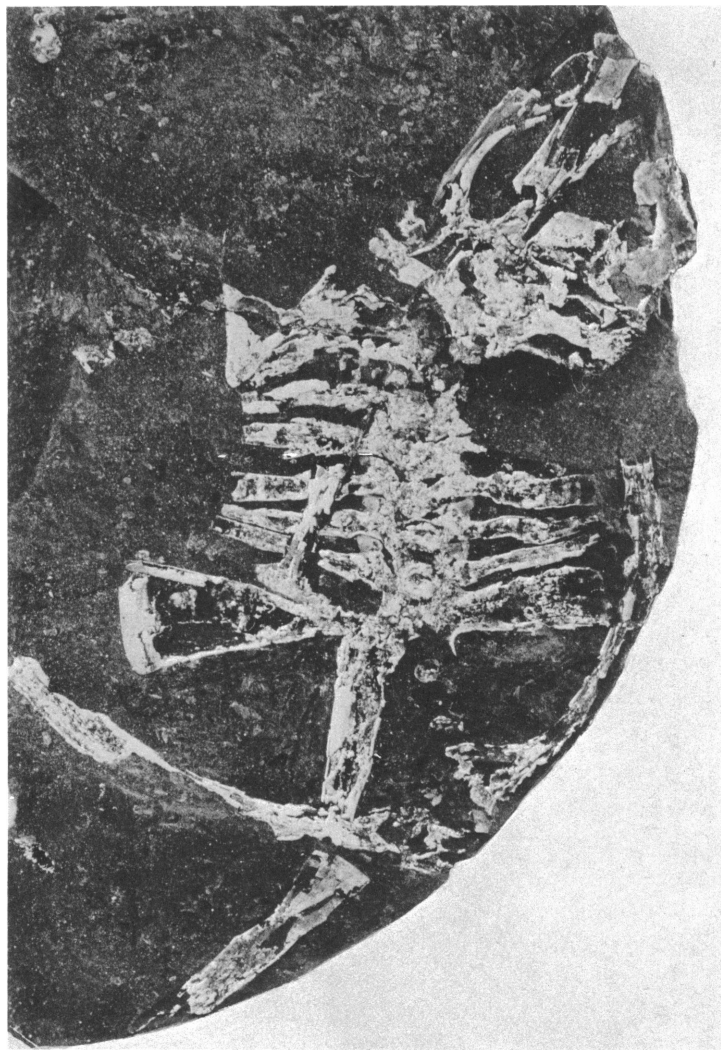


FIG. 3. Dorsal section of *Eorubeta nevadensis* (A.M.N.H. No. 7602) under ultraviolet light at 3660 Å. $\times 1.7$.

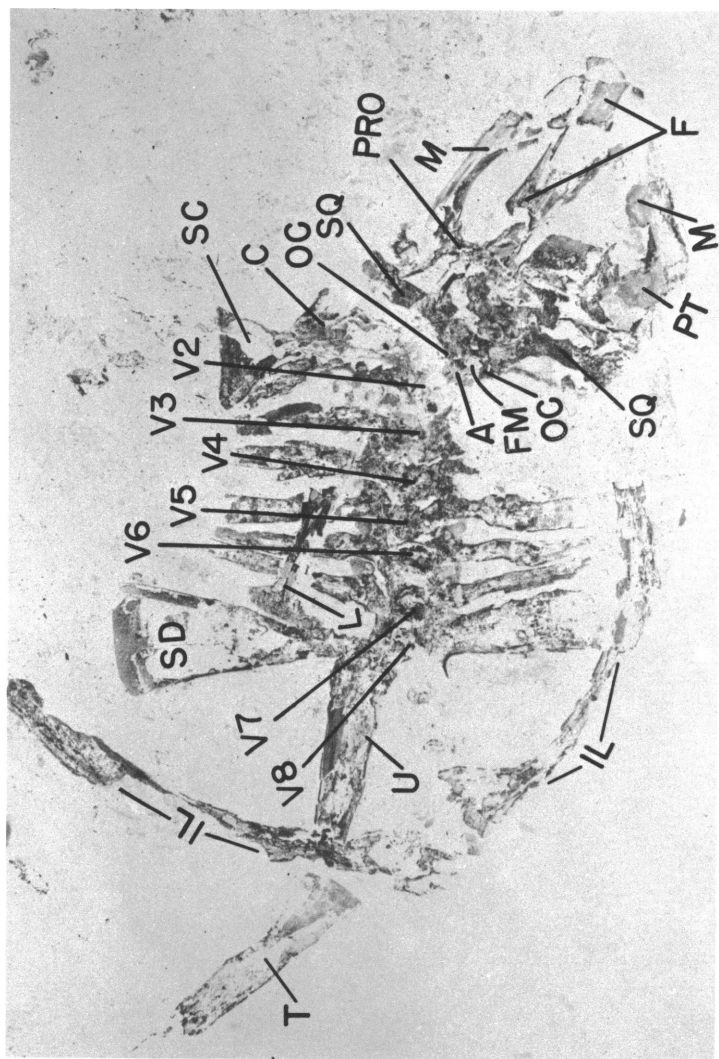


FIG. 4. Dorsal section of reverse print of *Eorubeta nevadensis* (A.M.N.H. No. 7602). $\times 1.7$. Symbols: a, altas; c, coracoid (?); f, frontoparietal; fm, foramen magnum; il, ilium; l, unknown limb bone (?); m, maxilla; oc, occipital condyle; pro, prootic; pt, pterygoid; sc, scapula; sd, sacral diapophysis; sq, squamosal; t, tibiofibula; V2-V8, second to eighth vertebrae; u, urostyle. $\times 1.7$.

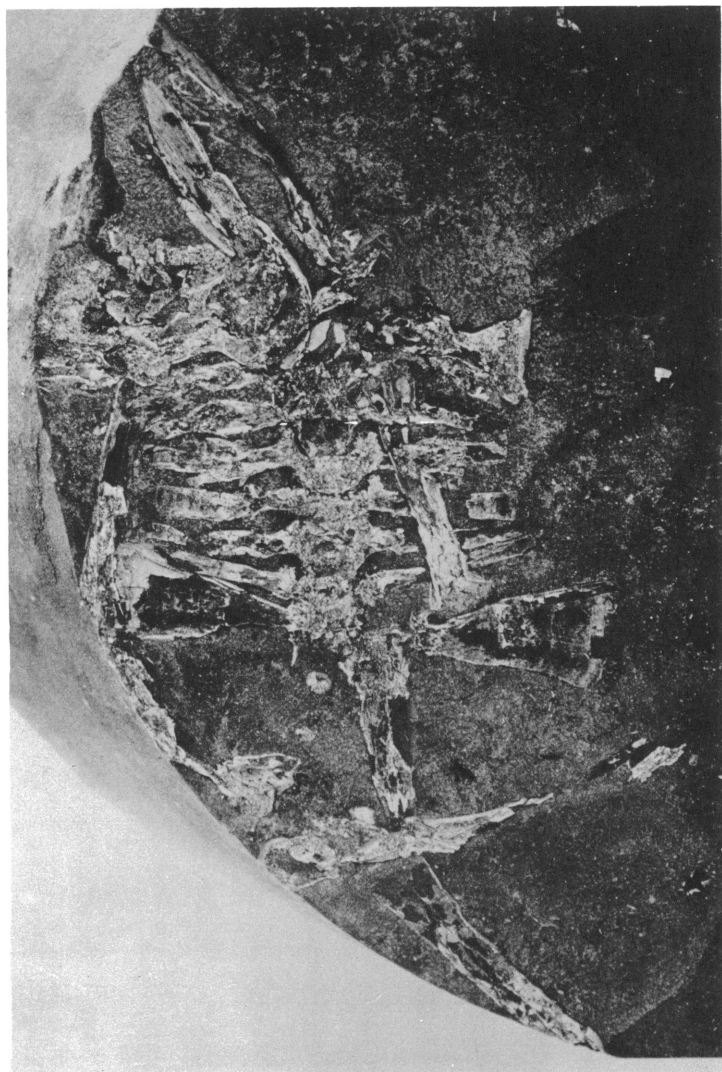


FIG. 5. Ventral section of *Eorubeta nevadensis* (A.M.N.H. No. 7602) under ultraviolet light at 3660 Å. $\times 1.7$.

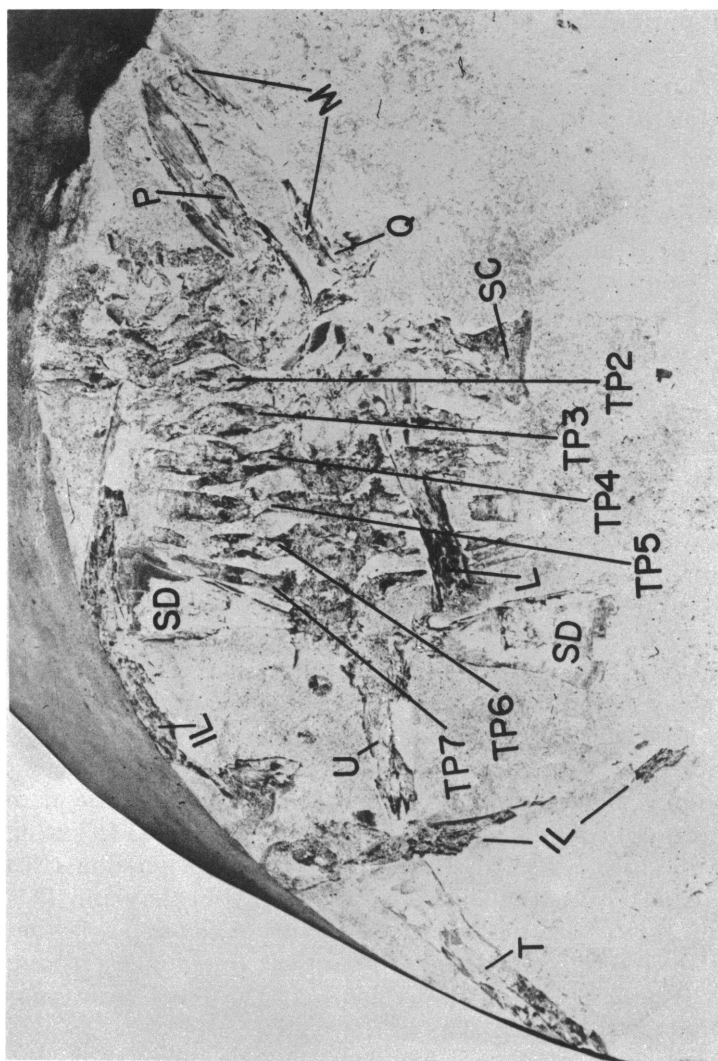


FIG. 6. Ventral section of reverse print of *Eorubeta nevadensis* (A.M.N.H. No. 7602). Symbols: il, ilium; l, unknown limb bone (?); m, maxilla; p, parasphenoid (?); q, quadratejugal (?); sd, scapula; sc, scapula; t, tibiofibula; u, urostyle. $\times 1.7$.

Ventral imprint: Only a small portion of the skull remains here. The right border of the skull is represented by the maxilla and its impression. From the anterior border of the maxilla we have removed a small piece of the maxilla which clearly bears alveoli and thus indicates a toothed maxilla. The maxilla continues posteriorly and makes contact with the occipital region of the skull by probably what is left of the quadratojugal. A small piece of quadratojugal and squamosal may be visible. A large flat bone is visible, which represents the parasphenoid portion of the palate. Other elements of the skull are indistinguishable. Because this fragment is the reverse of the upper imprint, the scapula, the unknown bone, and the ilia have mirror relations to those of the upper half.

As interpreted above, the posterior portion of the skull, which includes the occipital region, prootic, and squamosal, has been crushed flat but bears a superficial resemblance to a more posterior vertebra. If this large area were to be considered the first vertebra, or atlas, the specimen would be the only frog known in which the ribs or transverse processes were of such huge size. Usually frogs are completely lacking in processes on the atlas, but, if present, they are of small size. Should this be considered an atlas, which would be most improbable, then there would be eight presacral vertebrae which is a vertebral count known in many Australian leptodactylids. If, on the other hand, this region is considered a second vertebra, then there would be a small atlas anterior to it. Such an interpretation would bring the vertebral count up to nine and place the fossil, in this respect, among the more primitive frogs. In contrast to these interpretations are the following features of the fossil which indicate that the area in question is in neither of the two categories and therefore is a part of the skull. This region is in contact with the posterior elements of the upper jaw on both sides, which would of course be difficult to explain unless it were an area of the skull. Second, if this region were a vertebra, little space is allowed for the remaining parts of the skull.

Measurements are of limited importance in this specimen, as the entire specimen has been crushed to almost a smear. The sacral diapophyses are one of the few complete structures. They are 16 mm. in breadth as measured from the centrum to their lateral limits.

RELATIONSHIPS OF *Eorubeta*

An examination of the photographs will reveal the following distinctive features of this frog. There is a vertebral column which is made up of seven presacral vertebrae, with a sacrum having distally

expanded sacral diapophyses. There are an extremely long ilium and a strong urostyle. The dorsal vertebrae bear long transverse processes which are expanded distally. The transverse processes of the posterior vertebrae are equal in breadth to those of the anterior vertebrae. A small fragment from the maxilla of the lower half of the core has been removed, and it clearly bears alveoli of teeth. The above combination of characters clearly precludes any of the primitive families of frogs because of a smaller number of vertebrae (eight presacral) and the lack of any indication of vertebral development in the anterior region of the urostyle. The presence of enlarged transverse processes on the posterior vertebrae precludes from consideration virtually all the families of the higher frogs (Neobatrachia of Reig, 1958) except the Leptodactylidae, Hylidae, and Ranidae. The presence of a toothed maxilla precludes from consideration the Dendrobatidae, Atelopodidae, Centrolenidae, and the bufonids, including those that may have enlarged transverse processes posteriorly (as *Bufo superciliaris* and *Ansonia*). The dilated sacral diapophysis eliminates the Ranidae, because this family also has sacral diapophyses which are generally reflexed backward and not dilated. As a result there remain but two families to which this frog can belong—the Leptodactylidae or the Hylidae. In general most of the Hylidae have reduced transverse processes as the series proceeds posteriorly along the body axis. In some hylids, such as *Acris crepitans* and possibly *Hyla gratiosa*, there is almost equal development of the transverse processes along the body axis, but these are generally thin, bony, needle-like projections rather than broad, flattened, transverse projections as in this fossil. The sacral diapophyses of the fossil are dilated anteriorly as compared to those of most hylids. Some hylids have the dilations equally developed or slightly more extended anteriorly, but not in association with large transverse processes. It is admitted that the Hylidae are a huge family, and the number of species and genera examined (seven genera, 20 species) is only a small sample of the entire family. The only family in which known members correspond fairly well to the fossil is the Leptodactylidae. Among the New World leptodactylids only *Eupsophus*, some species of *Eleutherodactylus*, and the toothless *Batrachophrynus* have equal or subequal development of all the transverse processes along the vertebral axis. Despite their proper width, the transverse processes of *Eupsophus* and *Batrachophrynus* are much too weak and thin posteriorly to compare favorably with those of the fossil. None of the three genera has expanded sacral diapophyses, and all have the sacral diapophysis reflexed backward. In comparison with

Australian leptodactylids (Parker, 1940; Moore, 1959) the fossil compares favorably with only two genera: *Mixophyes* and *Lechriodes*. In both of these the transverse processes are equal or subequal in width along the vertebral axis, and the sacral diapophyses are strongly dilated as in the fossil. The fossil is readily distinguishable from these by the presence of a transverse process on the atlas of *Lechriodes* and by the presence of eight presacral vertebrae common to both genera. Lastly neither of the aforementioned shows distally expanded transverse processes.

In conclusion the fossil under study appears to be best fitted to the present concepts of the Leptodactylidae, although not with absolute certainty. If it is considered a leptodactylid, as the evidence at present indicates, it appears to be closer to the Australian leptodactylids than to the South American ones. It is admitted that only a few genera of the latter group were available for study (*Calyptocephallela*, *Telmato-bius*, *Batrachophrynus*, *Eleutherodactylus*, *Ceratophrys*, *Eupsophus*, and *Physalaemus*), but the sample is perhaps adequate to indicate general relationships. As a result we may conclude that the fossil under study appears to be related to some of the Australian leptodactylids or possibly to the South American *Batrachophryne*. It is impossible to determine at this time how much resemblance is the result of parallelism and how much is real relationship. Certainly some zoogeographers may object to a report of an Australian section of the Leptodactylidae in North America. If I have reached a valid conclusion as to what section of the Leptodactylidae is represented here, then perhaps we may wonder how valid our zoogeographic speculations are without a fossil record.

REMARKS

Two frogs (A.M.N.H. Nos. 7602, 7603) were obtained at slightly different levels from the same well core. A third frog from White Pine County, Nevada, already listed in the published accessions of the Los Angeles County Museum, has been briefly examined. The matrix is of the same type, with the same invertebrate fauna, as the two well cores in the American Museum of Natural History collections. The discovery of three frogs at the same approximate level indicates that this formation must bear a bed superabundant in frogs. Examination of other well cores should be made.

Winfrey (1958) quotes, from personal communication with Harold Kellogg, my tentative identification of the frog as near *Eopelobates*. This identification was made from only one fragment and without the

benefit of ultraviolet light. Winfrey (1958) states that the frog was included in Member C of the Sheep Pass formation. Kellogg (MS) has corrected this observation and notes that the actual depth places the fossil in Member B of the same formation. The associated non-marine ostracods seem to indicate an age from Paleocene to lower Eocene. It is the opinion of Kellogg (MS) that the age of the deposit is early Eocene.

The importance of this fossil find is that it is the earliest definitely reported leptodactylid remains for North America. Actually some of the frog remains from the Trinity Sands (Zangerl and Denison, 1950) most probably represent a primitive leptodactylid or some close relative. The aforementioned frogs are now under study by the author. If *Eorubeta* is properly allocated, it may indicate a world-wide distribution for some Australian elements of the modern frog fauna. Much more will be learned when the two other frogs (A.M.N.H. No. 7603 and the specimen in the Los Angeles County Museum) from this formation are reported on. A.M.N.H. No. 7603 is in need of further preparation and is now under study.

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