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NOTE

MAMMAL-LIKE TOOTH FROM THE UPPER TRIASSIC OF GERMANY

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Recent discoveries have extended the antiquity of the Mammalia (sensu Lucas and Luo, 1993) back to the late Carnian, about 228 Ma, and reveal a greater diversity of Late Triassic mammals and advanced, non-mammalian cynodonts than was known as little as two decades ago (compare reviews of Clemens et al., 1976 and Clemens, 1986, with those of Lucas and Hunt, 1994 and Godefroit and Battail, 1997). We now add to this Late Triassic diversity a tooth from the German Keuper that is significant because it potentially fills a morphological gap in the evolutionary transition from the postcanine tooth of a dromatheriid cynodont to that of a morganucodontid mammal. SMNS = Staatliches Museum für Naturkunde, Stuttgart, Germany.

PROVENANCE AND AGE

Seegis (1997:pl. 27, fig. 10) illustrated SMNS 80766, a tiny tooth in a jaw fragment, identifying it as ''Cynodontia indet.'' This fossil was collected at Geissgurgelbach, northeast of Stuttgart in Baden-Württemberg (Gauss-Kruger-Coordinates: R 35 41 690/H 54 15 740) (Fig. 1). The specimen came from the lower, dolomitic part of the Obere Lehrbergbank, which is in the upper part of the Lehrbergschichten (=upper part of Untere Bunte Mergel; Fig. 1). These strata are of Otischalkian (late Carnian) age based on the presence of the primitive phytosaur *Paleorhinus* (in the Kieselsandstein) and the primitive metoposaurid *Metoposaurus* (Lucas, 1998). Palynology also is consistent with a late Carnian age (Seegis, 1997).

DESCRIPTION

SMNS 80766 (Fig. 2) is a single tooth in a bone fragment. Antero-posterior length of the tooth crown is 1.12 mm, and maximum crown width is 0.58 mm. The principal crown cusp is inclined, presumably posteriorly, and one side of the tooth is convex, presumably labially. The bone rises posterior to the tooth, which is apparently the base of the ascending ramus of the dentary. If we have oriented these landmarks correctly, then SMNS 80766 is the lower right, posteriormost postcanine tooth in a dentary fragment.

The tooth crown is dominated by a single, tall, conical cusp (cusp a). This cusp has a blunt apex with a small, circular, abapical wear facet. Cusp a has a nearly flat (very slightly convex) surface that comprises most of the lingual aspect of the tooth. The labial surface of cusp a is more convex with several striae that originate near the crown apex and diverge toward the crown base.

Cusp b is much smaller than and lower than cusp a. Cusp b is at the anterior edge of the tooth with a small cleft separating it from cusp a. Thus, viewed lingually, cusp b is a very small, low, blunt triangle.

A chip missing from the postero-labial edge of the tooth probably included a low cusp c. The postero-labial part of the crown is a broad, slightly concave cingular shelf. The anterior edge of this cingulid begins near the postero-labial slope base of cusp a and widens posteriorly so that the widest part of the crown is posterior to cusp a. The labial edge of the cingulid is a low ridge with three tiny bumps that may be called cuspids (or stylids). The crown then narrows somewhat posteriorly to be gently rounded. Thus, the occlusal shape of the crown is a very acute triangle with its steep apex pointed anteriorly.

The crown base below the cusps is columnar, and the root base is divided into two, highly divergent roots. This root division begins well below the crown base.

DISCUSSION

SMNS 80766 is a unique dental morphotype. It probably represents a new taxon, but we believe it is not a sufficiently complete specimen upon which to base a new name. We thus identify SMNS 80766 as an indeterminate cynodont (as did Seegis, 1997), and note that it has morphological features that distinguish it from both dentally advanced cynodonts (dromatheriids) and primitive mammals (morganucodontids).

SMNS 80766 has more divided roots than any dromatheriid. Its crown is not as trenchant as the typical dromatheriid tooth, and no dromatheriid tooth has a cingulid. However, unlike most mammals (*Sinoconodon* is an exception: Crompton and Luo, 1993; Luo, 1994), there is no evidence that SMNS 80766 interlocked with the opposing upper tooth; i.e., it lacks a system of wear facets. Furthermore, in contrast to early mammals such as *Morganucodon* (e.g., Mills, 1971; Kermack et al., 1973; Clemens, 1980), *Brachyzostrodon* (Sigogneau-Russell, 1983; Hahn et al., 1991) and *Megazostrodon* (Crompton, 1974; Gow, 1986), SMNS 80766 lacks cuspids other than a-b-c, has no antero-lingual cingulid and does not have root division up to the crown base. Note, though, that in the Early Jurassic mammal *Sinoconodon* not all postcanine roots are fully divided (Luo, 1994; Zhang et al., 1998). In SMNS

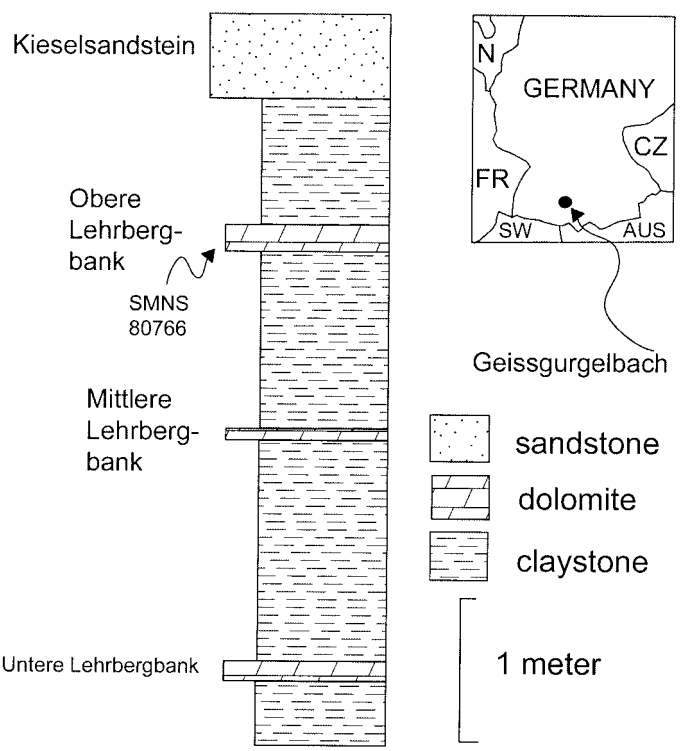

FIGURE 1. Stratigraphic section of the Lehrbergschichten at Geissgurgelbach showing location of horizon that yielded SMNS 80766 and inset map showing the locality at Geissgurgelbach.

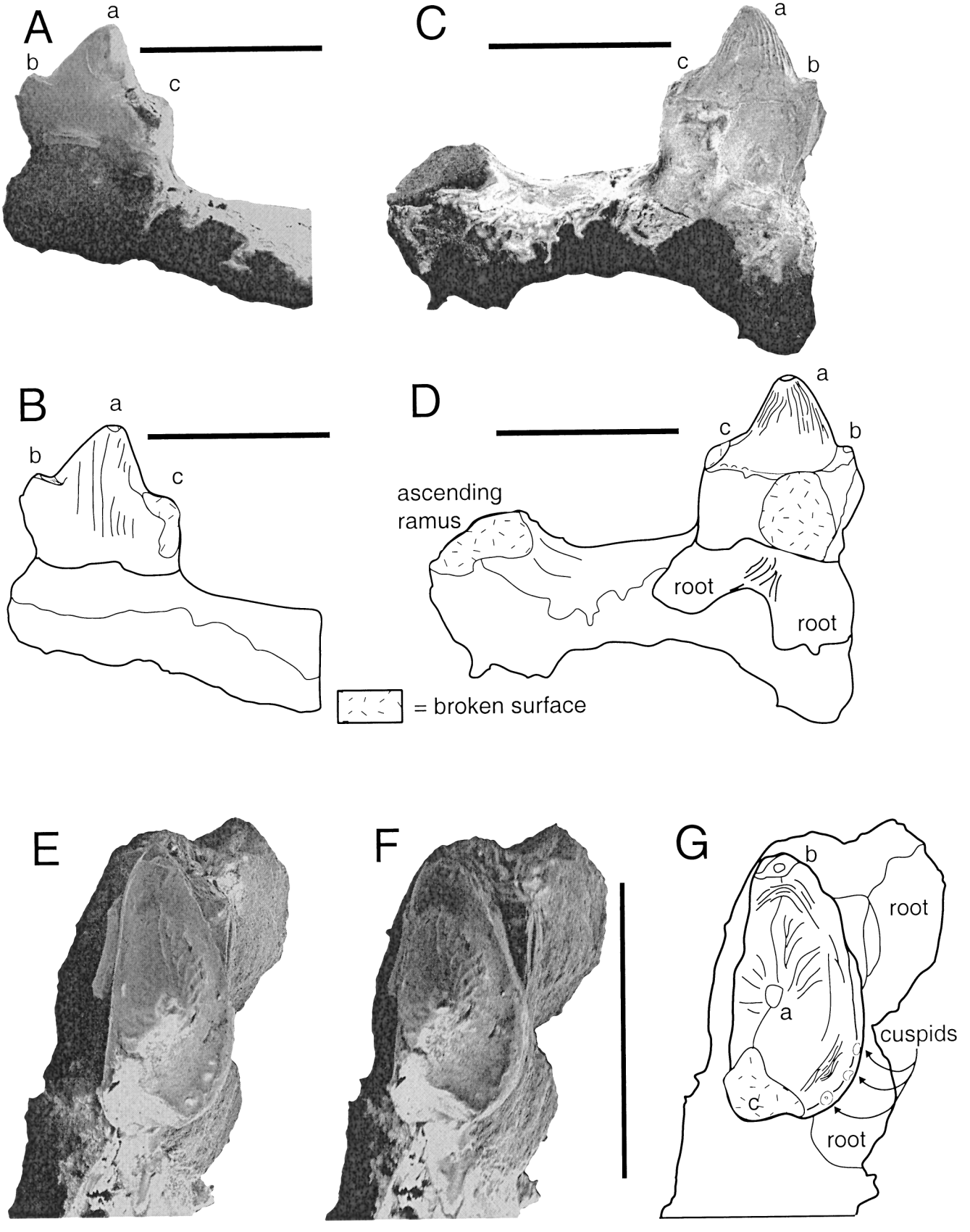

FIGURE 2. SEM microphotographs of SMNS 80766, right lower posteriormost postcanine tooth of a cynodont. **A**, **B**, lingual view. **C**, **D**, labial view. **E**, **G**, occlusal (stereophotograph) view. Scale bars = 2 mm.

80766, cusps b and c (?) are also extremely small relative to cuspid a, a feature more characteristic of dromatheriids than of early mammals (Clemens, 1980; Hahn et al., 1994).

SMNS 80766 can thus be envisioned as a postcanine tooth morphology intermediate between that of a dromatheriid and a morganucodontid. Further division of the root base, addition of an antero-lingual cingulid, and cuspids with development of interlocking wear would transform the SMNS 80766 tooth morphology into a morganucodontid tooth.

SMNS 80766 is older than the oldest morganucodontids (they are late Revueltian=late Norian in age: Lucas, 1998) and slightly younger than/approximately the same age as the oldest dromatheriids, which are from the Turkey Branch Formation in Virginia (Godefroit and Battail, 1997; Lucas, 1998). The German tooth thus represents a plausible link, both morphologically and temporally, between dromatheriids and morganucodontids. As such, it supports arguments (e.g., Hahn et al., 1994) that the origin of mammals is from dromatheriids, not from tritylodontids.

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LITERATURE CITED

Clemens, W. A. 1980. Rhaeto-Liassic mammals from Switzerland and West Germany. Zitteliana 5:51–92.

——— 1986. On Triassic and Jurassic mammals; pp. 237–246 *in* K. Padian (ed.), The Beginning of the Age of Dinosaurs: Faunal Change Across the Triassic–Jurassic Boundary. Cambridge University Press, Cambridge.

———, J. A. Lillegraven, E. H. Lindsay, and G. G. Simpson. 1976. Where, when, and what—a survey of known Mesozoic mammal distribution; pp. 7–58 *in* J. A. Lillegraven, Z. Kielan-Jaworowska, and W. A. Clemens (eds.), Mesozoic Mammals: The First Two-thirds of Mammalian History. University of California Press, Berkeley.

Crompton, A. W. 1974. The dentitions and relationships of the southern African Triassic mammals, *Erythrotherium parringtoni* and *Megazostrodon rudnerae*. Bulletin of the British Museum (Natural History) Geology 24:397–437.

———, and Z. Luo. 1993. Relationships of the Liassic mammals *Sinoconodon, Morganucodon oehleri*, and *Dinnetherium*; pp. 30–44 *in* F. S. Szalay, M. J. Novacek, and M. C. McKenna (eds.), Mammal Phylogeny Mesozoic Differentiation, Multituberculates, Monotremes, Early Therians, and Marsupials. Springer-Verlag, New York.

Godefroit, P., and B. Battail. 1997. Late Triassic cynodonts from Saint-Nicolas-de-Port (north-eastern France). Geodiversitas 19:567–631.

Gow, C. E. 1986. A new skull of *Megazostrodon* (Mammalia, Triconodonta) from the Elliot Formation (Lower Jurassic) of southern Africa. Palaeontologia Africana 26:13–23.

Hahn, G., R. Hahn, and P. Godefroit. 1994. Zur Stellung der Dromatheriidae (Ober-Trias) zwischen den Cynodontia und den Mammalia. Geologica et Palaeontologica 28:141–159.

———, D. Sigogneau-Russell, and P. Godefroit. 1991. New data on *Brachyzostrodon* (Mammalia; Upper Triassic). Geologica et Palaeontologica 25:237–249.

Kermack, K. A., F. Mussett, and H. W. Rigney. 1973. The lower jaw of *Morganucodon*. Zoological Journal of the Linnean Society 543: 87–175.

Lucas, S. G. 1998. Global Triassic tetrapod biostratigraphy and biochronology. Palaeogeography, Palaeoclimatology, Palaeoecology 143:347–384.

———, and A. P. Hunt. 1994. The chronology and paleobiogeography of mammalian origins; pp. 335–351 *in* N. C. Fraser and H. -D. Sues (eds.), In the Shadow of the Dinosaurs: Early Mesozoic Tetrapods. Cambridge University Press, Cambridge.

———, and Z. Luo. 1993. *Adelobasileus* from the Upper Triassic of West Texas: the oldest mammal. Journal of Vertebrate Paleontology 13:309–334.

Luo, Z. 1994. Sister-group relationships of mammals and transformations of diagnostic mammalian characters; pp. 98–128 *in* N. C. Fraser and H.-D. Sues (eds.), In the Shadow of the Dinosaurs: Early Mesozoic Tetrapods. Cambridge University Press, Cambridge.

Mills, J. R. E. 1971. The dentition of *Morganucodon*; pp. 29–63 *in* D. M. Kermack and K. A. Kermack (eds.), Early Mammals. Supplement 1. Zoological Journal of the Linnaean Society 50.

Seegis, D. 1997. Die Lehrbergschichten im mittleren Keuper von Süddeutschland—Stratigraphie, Petrographie, Paläontologie, Genese. Remshalden, Verlag Manfred Hennecke, 382 pp.

Sigogneau-Russell, D. 1983. Nouveaux taxons de mammiferes Rhetiens. Acta Palaeontologica Polonica 28:233–249.

Zhang, F., A. W. Crompton, Z. Luo, and C. R. Schaff. 1998. New fossil evidence for evolution of mammalian diphyodont dentition. Vertebrata PalAsiatica 36:197–217.

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