

# *Tibiaporrhais*, a New Late Cretaceous Genus of Aporrhaidae Resembling *Tibia* Röding

by

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**Abstract.** Newly discovered late Campanian specimens of the gastropod *?Nudivagus cooperensis* Stephenson, 1941, reveal a spined outer lip characteristic of the Aporrhaidae. This feature necessitates removal of this species from the Cerithiidae and placement in a new genus, *Tibiaporrhais*, of the Aporrhaidae. The type species of *Nudivagus*, *N. simplicus* Wade, 1917, lacks evidence of an aporrhaid aperture and is retained in the Cerithiidae because of this and other differences in shell morphology that separate it from *?Nudivagus cooperensis*. Unfortunately, a complete aperture for the type species of *Nudivagus* is unknown; *Nudivagus* therefore cannot be absolutely precluded from the Aporrhaidae.

*Tibia japonica* (Nagao, 1932), from the Campanian of Soviet Sakhalin, also is placed in *Tibiaporrhais* gen. nov., as is a similar undescribed species from the Campanian of California. Similarities in shell morphology between *Tibiaporrhais* and *Tibia* Röding, 1798, suggest either a relatively close evolutionary relationship between the genera, implying that *Tibia* may be more closely allied to the Aporrhaidae than to the Strombidae, or that the genera are homeomorphic. Anatomical research is needed in order to assess these possibilities.

## INTRODUCTION

The classification of fossil gastropods lacking ornament is often a difficult and confusing task, especially when the easily damaged apertures are usually incomplete. This problem is especially evident in the case of the Late Cretaceous *?Nudivagus cooperensis*, which was known for over 40 yr before newly discovered specimens with nearly complete apertures indicated the need for placement in a new genus of the Aporrhaidae.

This paper will name and document *Tibiaporrhais*, the new genus of the Aporrhaidae, and further describe and illustrate *Tibiaporrhais cooperensis* (Stephenson, 1941), the type species. In addition to this late Campanian to early Maastrichtian species of the Western Interior and Gulf Coast of North America, two Campanian north Pacific species, *Tibia japonica* (Nagao, 1932) and a newly discovered species from California, will be assigned to *Tibiaporrhais*. These latter species may provide ancestors to the present day Indo-Pacific *Tibia*.

## SYSTEMATIC PALEONTOLOGY

The specimens described or mentioned in this paper have the following repository or locality (loc.) abbreviations: USNM—National Museum of Natural History (formerly

United States National Museum); UCM—University of Colorado Museum, Boulder, Colorado; USGS—U.S. Geological Survey; CAS—California Academy of Sciences.

Family APORRHAIIDAE Mörch, 1852

Genus *Tibiaporrhais* Elder, gen. nov.

(Figures 1, 3, 4, 6–9)

**Type species:** *?Nudivagus cooperensis* Stephenson, 1941, here designated.

**Diagnosis:** A large, high spired aporrhaid having (1) subdued sculpture consisting of fine spiral striae and growth lines, and (2) a slightly expanded outer lip with two, moderately long, spinelike processes that arise from indistinct carinae that extend for less than the latter half of the body whorl.

**Description:** Shell large for family (8 to 10 cm in length); turriculate, having 8 to 11 whorls and spire angle of 20 to 30 degrees. Whorl sides broadly convex anteriorly and slightly constricted posteriorly below a distinct, but closely appressed suture. Surface ornament weak; consisting of numerous crowded, narrow spiral striae and fine, sinuous axial growth lines. Aperture moderately elongate and trap-

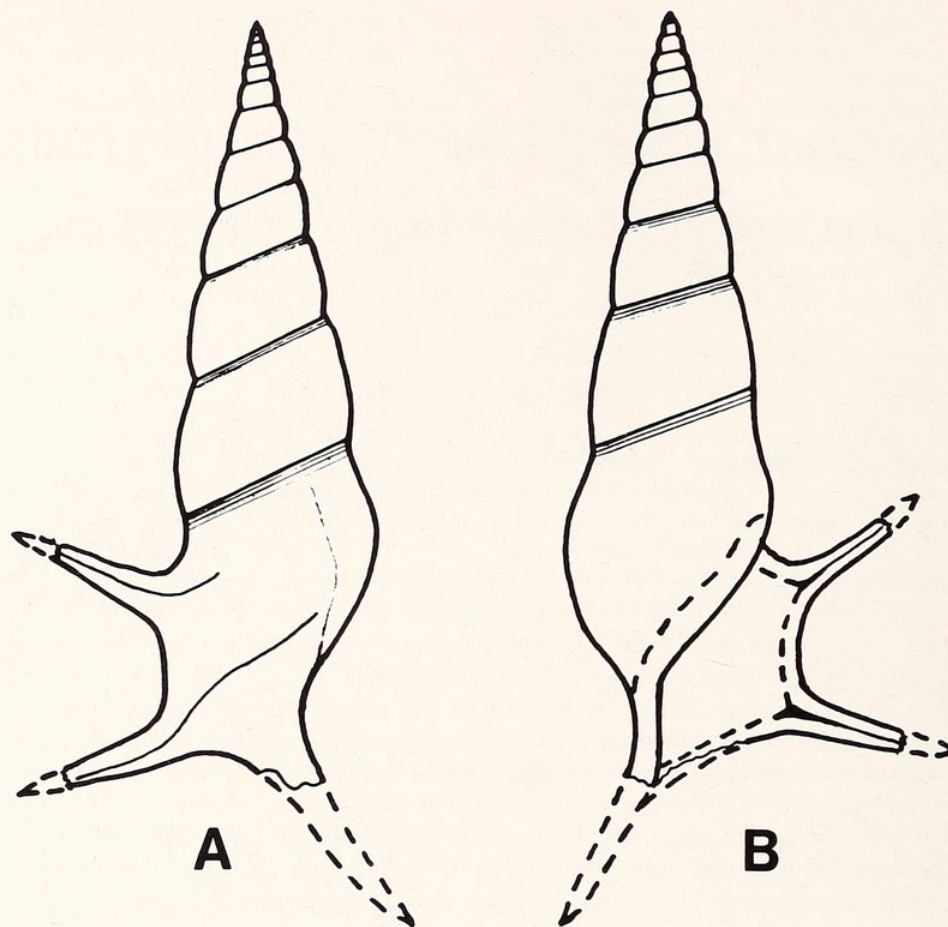


Figure 1

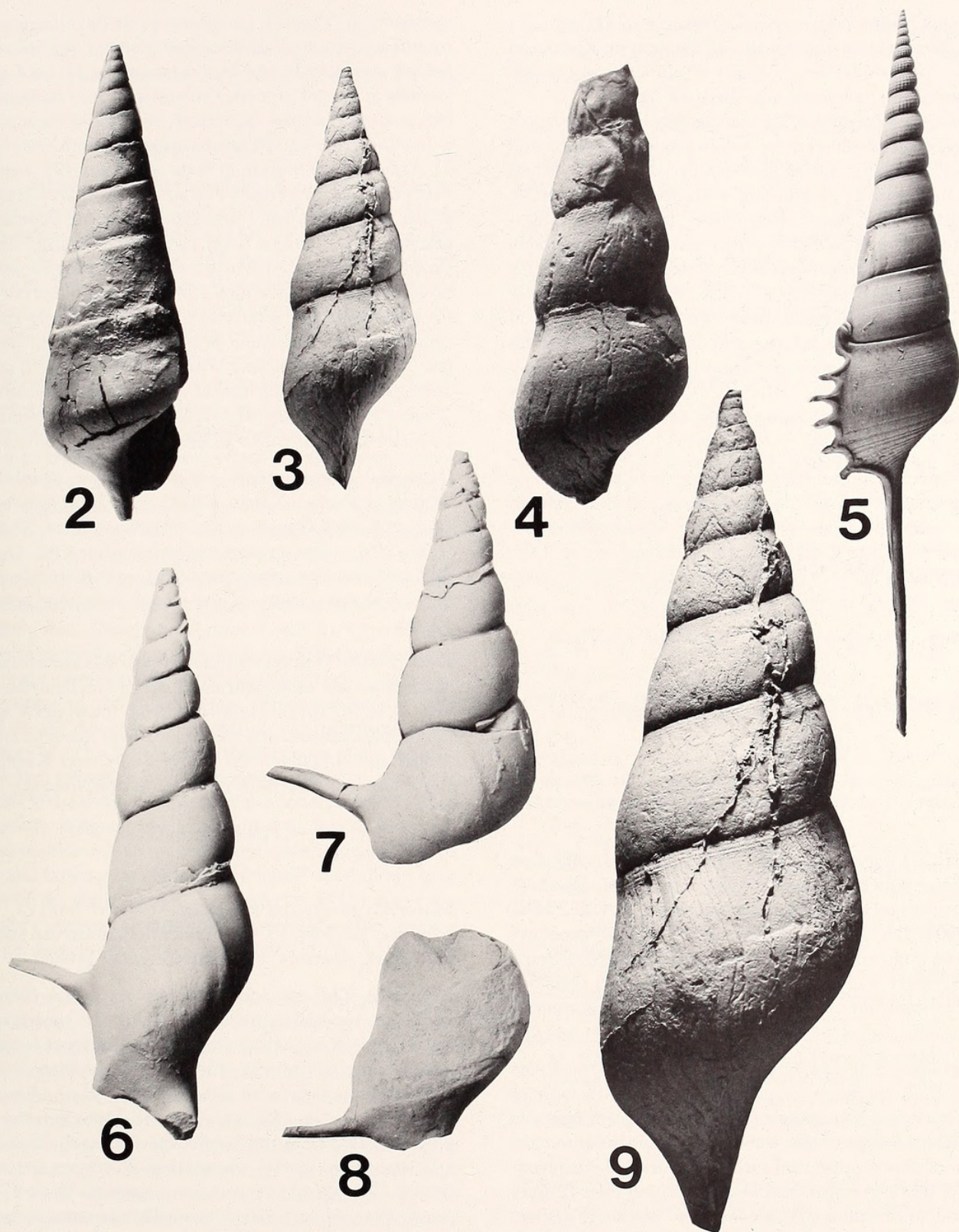
Reconstruction of *Tibiaporrhais cooperensis* (Stephenson, 1941) based on a composite of three specimens,  $\times 1$ . A, abapertural view; B, apertural view. Dashed lines denote portions of shell not present on any specimen and therefore subjectively drawn.

ezoidal. Outer lip slightly flaring with two discrete spine-like processes originating from two indistinct carinae that extend for less than one-third of body whorl; posterior process projects in slightly posterior direction, anterior process projects in horizontal to slightly anterior direction. Anterior canal broken on all specimens, but suggestive of moderate length (Figure 1). Inner lip slightly callused. Lacks evidence of posterior canal or callus extending upwards onto spire.

**Remarks:** This genus is most similar to *Dicroloma* Gabb, 1868, but differs significantly in lacking carinae on the spire. *Tibiaporrhais* also is similar to *Lispodesthes* White, 1875, but has a higher spire and lacks secondary callus. The new genus differs significantly from *Aporrhais* DaCosta, 1778, *Tessarolax* Gabb, 1864, and *Helicaulax* Gabb, 1868, in not possessing a posterior canal attached to the spire by callus, and from *Gymnarus* Gabb, 1868, *Pyktes* Popenoe, 1983, and *Tephlon* Popenoe, 1983, by having a higher spire, and by lacking secondary callus and a heavy, bent, posterior projection of the outer lip. *Tibiaporrhais* differs from *Anchura* Conrad, 1860, by lacking

the broadly flaring outer lip with posteriorly projecting process characteristic of the latter genus. The lack of both a broadly flaring outer lip and prominent surface ornament, as well as the presence of two discrete lateral spines, serve to distinguish *Tibiaporrhais* from *Drepanochilus* Meek, 1864, *Arrhoges* Gabb, 1868, and *Graciliala* Sohl, 1960.

*Tibiaporrhais* apparently includes not only the late Campanian to early Maastrichtian species ?*Nudivagus cooperensis*, but also the Campanian species *Tibia japonica* (Nagao, 1932) from Sakhalin. The surface ornament and constriction below the suture are slightly stronger on the latter species than the former (for comparison see NAGAO, 1932:44–45, pl. 7, figs. 1–3, 5, 6; HAYAMI & KASE, 1977: 59, pl. 7, fig. 4), but their overall shape, size, and ornamentation are very similar. The apertures of all *Tibia japonica* specimens are imperfect, but NAGAO (1932) states that the thin outer lip bears two processes of unknown length that originate from relatively indistinct carinae on the body whorl (see NAGAO, 1932:pl. 7, fig. 3b). In addition, a specimen from Campanian strata in the Sacramento Valley of California (Figure 4) bears strong resem-



## Explanation of Figures 2 to 9

Figure 2. *Nudivagus simplicus* Wade, 1917; Holotype, USNM 32938,  $\times 1$ . Figure 3. *Tibiaporrhais cooperensis* (Stephenson, 1941); UCM 30670, latex peel of external mold,  $\times 1$ . Figure 4. *Tibiaporrhais* sp.; USNM 442113,  $\times 1$ . Figure 5. *Tibia fusus* Linné, 1758; CAS 66959,  $\times 0.5$ . Figures 6–9. *Tibiaporrhais cooperensis* (Stephenson, 1941); UCM 30670. Figures 6, 7. Internal molds with posterior spinelike process intact,  $\times 1$ . Figure 8. Internal mold with anterior spinelike process intact,  $\times 1$ . Figure 9. Latex peel of external mold showing fine ornamentation of shell-surface,  $\times 2$ .

blance to *Tibiaporrhais japonica* (Nagao, 1932) and also is tentatively placed in *Tibiaporrhais*, despite its broken aperture that shows no evidence of spinelike processes. Features of this specimen are discussed below.

*Nudivagus* Wade, 1917, is not reassigned to the Aporrhaidae because evidence for an expanded aperture and apertural spines is lacking in the type species, *Nudivagus simplicus* (Figure 2). In addition, this species has a narrow, tabulate shoulder, flatter whorl sides, and sharper angulation from the anterior to peripheral sides of the body whorl relative to *Tibiaporrhais cooperensis* (Figure 3) (for comparison see WADE, 1917, 1926; STEPHENSON, 1941; SOHL, 1960). The shape of the growth lines and the spiral striae constituting the surface ornament of the two species are very similar, however, and incomplete apertures on all specimens of *Nudivagus simplicus* do not absolutely preclude this species from being congeneric with *T. cooperensis*.

**Occurrence:** *Tibiaporrhais* is known from strata of late Campanian and early Maastrichtian age in the Western Interior and Gulf Coast regions of the United States, respectively. It is also found in Campanian age strata of the eastern North Pacific in central California and of the western North Pacific in Soviet Sakhalin.

**Etymology:** *Tibiaporrhais*—A *Tibia*-like aporrhaid.

*Tibiaporrhais cooperensis* (Stephenson, 1941)

(Figures 1, 3, 6–9)

?*Nudivagus cooperensis* STEPHENSON, 1941:294–295, pl. 54, figs. 11, 12; SOHL, 1960:79; WOLFE & KIRKLAND, 1986:207.

**Material:** Holotype—USNM 76900, USGS collection 14063: one moderately well-preserved specimen with broken aperture and anterior canal. Hypotypes—UCM 30670, loc. 81007: two internal molds with posterior processes preserved and broken anterior canals, one internal mold of body whorl with anterior process preserved, and one well-preserved external mold without aperture or anterior canal.

**Description:** Shell thin, large, turriculate (preserved portions of adult specimens 75 to 90 mm in height), with 10 to 11 whorls and spiral angle of about 30 degrees (Figures 3, 6). Whorl sides broadly convex and slightly constricted anterior of closely appressed suture. Surface ornament consisting of weak spiral striae and axial growth lines (Figure 9). Spiral striae and interspaces broader and more distinct immediately anterior of suture, becoming narrower, less distinct, and finally disappearing on anterior half of whorls. Sinuous growth lines slightly prosocline below suture, increasing in angle on upper half of whorl, and arching over whorl periphery. Slightly prosocline poorly defined swelling developed one-third revolution back from aperture on external surface of body whorl; swelling well developed on internal mold and accompanied by a slight abapertural

constriction. Ventral periphery of body whorl broadly rounded. Two indistinct carinae present on body whorl behind spinelike lateral labral processes; anterior carinae sinuous at base of process, extending back to vertical swelling; posterior carinae posteriorly bending at base of spine, extending back less than one-quarter revolution (Figure 7). Anterodorsal margin of body whorl sharply constricted between anterior carinae and anterior canal. Length and shape of anterior canal uncertain; available material suggesting a moderately long, ventrally bending, spinelike process (Figure 1). Aperture moderately elongate and trapezoidal, but poorly defined from existing material. Outer lip slightly flaring with two 15 to 18 mm long spinelike processes; posterior spine projecting in posterior direction (ca. 70 degrees from axis of spire) (Figures 6, 7), anterior spine projecting in horizontal to slightly anterior direction (Figure 8). Inner lip slightly callused. Lacks evidence of posterior canal or callus extending upwards onto spire.

**Remarks:** *Tibiaporrhais cooperensis* differs from *Tibiaporrhais japonica* (Nagao, 1932) and *Tibiaporrhais* sp. (Figure 4) by having a greater apical angle (ca. 30 degrees versus 20 degrees), greater number of whorls (ca. 11 versus 8), finer and less prominent spiral striae, and less well-developed constriction of the whorl periphery below the suture.

**Occurrence:** Holotype from the lower Maastrichtian (*Exogyra cancellata* zone) Navarro Group, Neylandville Marl, near Cooper, Texas. Hypotypes from the upper Campanian (upper *Baculites compressum* to lower *Baculites cuneatus* zones), middle part of the Pierre Shale near Kremmling, Colorado (see Appendix for locality descriptions).

*Tibiaporrhais* sp.

(Figure 4)

**Material:** Illustrated specimen—USNM 442113, USGS Mesozoic loc. M4013. One moderately preserved specimen with spire, aperture, and anterior canal broken.

**Remarks:** This specimen strongly resembles *Tibiaporrhais japonica* in having a spire with ca. 8 whorls and an apical angle of ca. 20 degrees, and in being more constricted between the suture and whorl periphery than is *T. cooperensis* (compare with NAGAO, 1932:pl. 7, figs. 1, 2; HAYAMI & KASE, 1977:pl. 7, fig. 4). However, the lower whorl periphery is more rounded anteriorly than on *T. japonica*, more closely resembling *T. cooperensis* in this respect. The spiral striae and axial growth lines of *Tibiaporrhais* sp. appear to be intermediate in strength between those of *T. japonica* and *T. cooperensis*, although the worn nature of the shell surface makes this observation somewhat suspect. Overall characteristics of this specimen suggest that it belongs to a species closely allied to *T. japonica* and somewhat intermediate in character between that species and *T. cooperensis*; however, better material is needed before this apparently new species can be adequately described.

**Occurrence:** Forbes Formation of the Chico "series" (KIRBY, 1943) in the Rumsey Hills, Yolo County, California; from Campanian strata (see Appendix for locality descriptions).

### DISCUSSION

The distribution of *Tibiaporrhais* in the North Pacific, Western Interior, and Gulf Coast regions of North America further supports SOHL's (1967, 1971) suggested link between the North Pacific and Western Interior regions during the Late Cretaceous. Based on similarities in the distribution patterns of gastropod genera, particularly between Sakhalin and the Western Interior region (SOHL, 1967), SOHL (1971) hypothesized a northern migration route between the regions or an unknown "boreal" fauna supplying migrants to both regions simultaneously.

In addition, morphological similarities between the shells of *Tibiaporrhais* and the Indo-Pacific genus *Tibia* suggest a possible evolutionary link between these genera; both share the general characteristics of having (1) a high spire, (2) broadly convex whorls, (3) weak sculpture consisting primarily of fine spiral striae and axial growth lines, (4) a moderately flaring lip with digitations, and (5) a long to moderately long anterior siphonal canal that is straight to slightly bent (compare Figures 1 and 5). One notable difference in shell morphology between *Tibiaporrhais* and *Tibia* is the development of the posterior canal and callus on the spire of the latter genus. *Tibiaporrhais* is here placed in the Aporrhaidae based on the aporrhaid characteristics of (1) a high-spined shell having many whorls, (2) the two spinelike processes extending from the outer lip, and (3) the slightly bent, spinelike anterior canal. *Tibia* is presently assigned to the Strombidae, but differs from most strombids in having a higher spire, longer anterior canal, and lacking the "stromboid notch" that allows protrusion of the stalked right eye (ABBOTT, 1960); however, *Tibia* does possess the strombid features of stalked eyes, a hooklike operculum, and a long foot (H. & A. ADAMS, 1853; ABREA, 1975).

With POPENOE's (1983) reassignment of the genus *Pugnellus* Conrad, 1860, from the Strombidae to the Aporrhaidae, the earliest undoubted strombid is of latest Maastichtian age (POPENOE, 1983). Thus, *Tibia* possibly belongs to a conservative ancestral stock of strombids descending from or of common ancestry with *Tibiaporrhais*, and which split from the main stock of Strombidae at an early point in its radiation. *Tibia* may therefore retain some aporrhaid features while possessing some strombid characters. The ambiguous nature of *Tibia* and its similarity in shell morphology to *Tibiaporrhais* indicate the need for a comparative analysis of the soft-part anatomy of extant *Tibia* and other Strombidae and Aporrhaidae in order to assess properly their evolutionary relationships. Comparative analysis of DNA sequencing in these groups may also shed light on this problem. The results of such studies should determine the family to which *Tibia* is more closely allied, and whether the similarities in shell morphology between *Tibia*

and *Tibiaporrhais* reflect a close evolutionary relationship or merely homeomorphy in genera from two families of Strombacea.

### ACKNOWLEDGMENTS

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the central part of the Western Interior Seaway: a field guidebook for the Fourth North American Paleontological Convention, Boulder, Colorado, 1986.

## APPENDIX

### Locality Information

- USGS Collection 14063. Branch east of Texas Midland Rail Road, 0.4 mi. (0.6 km) N of Cooper, Delta County, Texas. Greenish-gray calcareous clay (marl) with calcium carbonate concretions. Collected by L. W. Stephenson, 1928.
- UCM Locality 81007. Near top of S side of prominent SE pointing butte. Grand County, Colorado, Kremmling 1:62,500 Quadrangle, NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 7, T3N, R80W. Collected by J. Kirkland, 1981-1982.
- USGS Mesozoic Locality M4013. SE side of intermittent creek, S of Petroleum Creek, N of Guinda VABM, Yolo County, California. Rumsey 1:24,000 Quadrangle, 1450 ft. (442 m) E and 2450 ft. (747 m) S of NW corner of sec. 11, T12N, R3W. Collected by E. Pessagno, 1965-1966.



Elder, William P. 1990. "TIBIAPORRHAI, A NEW LATE CRETACEOUS GENUS OF APORRHAIIDAE RESEMBLING TIBIA RODING." *The veliger* 33, 293–298.

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