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TWO TERTIARY MAMMALS FROM NORTHERN SOUTH AMERICA

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Very little is known of the Tertiary Mammalia of northern South America, i.e., those parts of the continent north of Argentina and Uruguay, and the few specimens that have been obtained from this vast region are therefore of considerable interest. This paper discusses two of these, one a hitherto undescribed giant rodent from the southwestern part of the Amazon basin, the other an ungulate from Peru which was first described by Anthony in 1924. Both specimens reënforce a slowly growing body of evidence which tends to show that the Tertiary mammalian fauna of the continent was, broadly speaking, a unit from the Paleocene up to the time of the Pliocene invasion from North America, evidence which, as far as it goes, gives no support to the Archelenis-Archiplata hypothesis. In addition, they provide the first clues to the correlation of certain rock units found in eastern Peru and in southwestern Brazil with the standard South American Tertiary continental sequence as worked out in Argentina.

For permission to study and describe this material I am indebted to the authorities of The American Museum of Natural History, particularly to the late Dr. Walter Granger and Dr. George Gaylord Simpson. The drawings are by the late Mr. Carl F. Gronemann, Staff Illustrator, Field Museum.

RODENTIA

Heptaxodontidae

PHOBEROMYS KRAGLIEVICH

Phoberomys bordasi,[2] new species

Megamys (?) MOOK, 1921, Bull. Amer. Mus. Nat. Hist., XLIV, p. 43.

? *Eumegamys* sp. PATTERSON, 1936, Herpetologica, I, p. 48.

TYPE.—Amer. Mus. No. 22666, RP_4–M_1. Collected by S. H. Roper.

HORIZON AND LOCALITY.—Probably late Miocene; horizon approximately equivalent in age to the Paraná of Entre Rios, Argentina, and situated at or near the base of Singewald's "Brown Beds" Series (see below, p. 6). Upper Rio Purús region, Province of Amazonas, Brazil.

DIAGNOSIS.—Much smaller than *P. burmeisteri* or *P. praecursor;* P_4 with three anterior laminae united externally as in *praecursor*, anterior lamina very small and antero-internal in position; M_1 with anterior lamina less concave posteriorly and narrower transversely than in *burmeisteri*.

REMARKS.—The genus *Phoberomys*, founded by Kraglievich (1926, p. 127) on "*Megamys*" *burmeisteri* Ameghino, is distinguished from other Argentinian members of the family by its lower molars, which consist of three distinct laminae

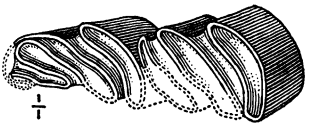

Fig. 1. *Phoberomys bordasi*, new species. Amer. Mus. No. 22666, type. RP_4–M_1, × 1/1. Broken plates, indicated by dotted lines, are projected to the grinding surface.

separated from each other by a thick deposit of cement. M_1 of the new species agrees perfectly in this character. P_4 agrees with the corresponding tooth of the other two species in the possession of four laminae, of which the first, as noted above, is exceedingly small. The laminae in-

[1] Field Museum of Natural History.

[2] I name this species in honor of my friend and confrere, Professor Alejandro F. Bordas of the Museo Argentino de Ciencias Naturales, in recognition of his contributions to South American paleomammalogy, and as a slight return for his unfailing courtesy in providing information concerning material in the collections under his charge.

crease progressively in width to the third, which is very slightly wider than the fourth, and become more transverse. The comparatively small size of *P. bordasi* will be apparent from the table of measurements; *P. burmeisteri* is one of the largest of known rodents.

AGE OF *P. bordasi*.—This specimen was the first fossil rodent to be found in northern South America.[1] That it is a member of a distinctive Argentinian genus is therefore of interest, an interest which is enhanced by the fact that the other two species are known only from the Paraná region. It has been suspected (Rusconi, 1933, p. 45; Patterson, 1936, p. 48) that the fossil crocodilians of the Rio Purús region may have been contemporaneous with those found near Paraná, therefore either of late Miocene or early Pliocene age. The present specimen supports this view. It was collected at the same locality as the type of the fossil alligatorid *Brachygnathosuchus braziliensis* Mook (= *Dinosuchus terror* Gervais, see Patterson, 1936) and almost certainly came from the same horizon. The importance of this fact for an understanding of the correlation of deposits occurring in eastern Peru and southwestern Bolivia is pointed out below.

As is well known (e.g., Kraglievich, 1934, pp. 19, 89–90), the fossils found at Paraná are believed to have been derived from two horizons which cannot be distinguished at that locality. Riggs and I (1939, pp. 160–161) have indicated an area in Catamarca, Argentina, that may contribute to a solution of this question, and it now appears that investigations along the upper reaches of the Purús may prove useful in this connection.

MEASUREMENTS IN MM.

		P. burmeisteri[2]			*P. praecursor*[2]	*P. bordasi*
P_4 greatest oblique diameter of grinding surface	—	—	40.0	39.0	30.0	18.5 (c)
" a–p diameter at center of tooth	—	28.0	31.0	31.0	25.0	16.4
" width of first lamina	—	12.0	14.5	18.5	10.0	4.0
" " " second lamina	—	20.0	24.5	25.0	19.0	9.5 (c)
" " " third lamina	—	23.0	31.5	26.0	24.0	13.7
" " " fourth lamina	—	20.2	25.5	23.5	18.0	13.3
M_1, greatest oblique diameter of grinding surface	29.0	—	—	—	—	19.5
" a–p diameter at center of tooth	23.0	—	—	—	—	16.5
" width of first lamina	21.0	—	—	—	—	12.0
" " " second lamina	25.5	—	—	—	—	15.7
" " " third lamina	22.0	—	—	—	—	14.5

[2] From Kraglievich, 1932A, pp. 226, 233.

PYROTHERIA

Pyrotheriidae

GRIPHODON ANTHONY

Griphodon peruvianus Anthony

G. peruvianus Anthony, 1924, Amer. Mus. Novitates, No. 111, pp. 1–3, Fig. 1.

The type specimen, Amer. Mus. No. 17724, was found by J. G. Richards in "highly folded gypsum beds" of uncertain age (see below) exposed on the bank of the Río Huallaga, "a day's journey down the river from Chepeza—the head of navigation—at Chiococa" (Anthony, 1924, p. 1).[3]

[1] Stehlin (1939) has recently recorded a close relative of *Proechimys* from the Miocene of Colombia.

[3] Neither of these localities is mentioned in Stiglich's "Diccionario Geográfico del Peru" (Lima, 1922), nor have I found them on any of the available maps. Sheet SB 18 (Loreto) of the American Geographical Society's Millionth Map of Hispanic America shows, however, a "Chipeda" at approximately the head of navigation (not marked on the map), and the road map of the Department of San Martin (Minist. de Fomento, Direc. Caminos y Ferrocariles, Serv. Tecnico de Caminos, Plan Vial de tres años, 1937–1938–1939) shows a "Chipaza" a short distance up river from the head of navigation. Evidently the three names are orthographic variants for one and the same spot.

Mr. Richards informs me (letter of April 14, 1941) that Chiococa consists of a single farm house "high up on the east bank of the Huallaga." The actual

It consists of a fragment of the left ramus with dm_4, M_1 and unerupted P_{3-4}.

P_3 is broken anteriorly and internally. Smaller than P_4, it is composed of two transverse lophids, the anterior narrower than the posterior as in *Pyrotherium*, connected externally by a longitudinal crest, probably a modified crista obliqua. This crest dips down between the lophids, forming a wide V; the external face of the tooth bears a vertical groove at the apex of the V. The crest continues down the posterior slope of the metalophid and turns internally around its base to form a prominent cingulum. A crest is also present on the anterior slope of the protolophid. Lo-

inent swelling on the external half of the anterior slope of the metalophid appears to be a vestige of the crista obliqua. The posterior cingulum is restricted to the base of the metalophid. The tooth as a whole is similar, except for a relatively wider protolophid, to P_3 of *Pyrotherium*.

M_1 differs but little from P_4. The prominent anterior cusp of the latter is represented merely by a slight median swelling on the anterior basal cingulum. The lophids incline backward to a slight extent and are somewhat bowed posteriorly as in *Pyrotherium;* they are rather higher internally then externally. The swelling on the anterior slope of the metalophid is slight.

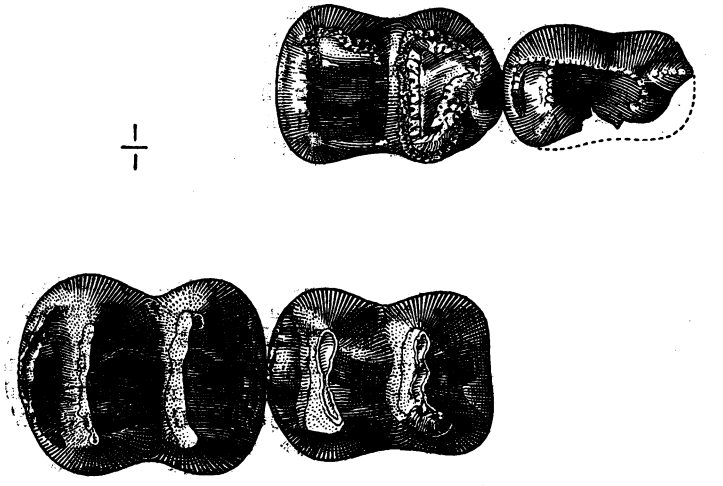

Fig. 2. *Griphodon peruvianus* Anthony. Amer. Mus. No. 17724, type. LP_{3-4}, dm_4–M_1, × 1/1.

phids, crests and cingula are strongly crenulated on all teeth of the specimen. P_4 has suffered some damage in the course of the preparation necessary for exposure. It is composed of two lophids, of almost equal width, and a prominent anterior cusp (an element probably present on P_3 also). This cusp, evidently the paraconid, appears to have been joined near its base by a ridge running from the external side of the protolophid. The lophids are not connected externally by a crest, but a prom-

In *Pyrotherium* no such remnant is present, but an M_2(?) of the Casamayor pyrothere *Carolozittelia* is almost exactly comparable in this respect with the tooth under discussion. The posterior cingulum is much larger than on P_4, and there is a slight secondary cingulum running behind and beneath it from the external side. The tooth is longer and narrower than M_1 or M_2 of *Pyrotherium* but is close in its length-width proportions to the *Carolozittelia* M_2 (?). Dm_4 of *Griphodon* is essentially a somewhat smaller replica of M_1 and requires no description. The size relationships of dm_4–M_1 are almost exactly as in *Pyrotherium*.

find was made a few hundred feet up a small tributary that enters the river a short distance downstream from Chiococa. The locality is below Yurimaguas and therefore in the southwestern extremity of the Department of Loreto.

The mandibular ramus is robust and was evidently deep, thus agreeing with that of *Pyrotherium*. The mental foramen, as noted by Anthony, is midway beneath P_4. The position of this foramen is variable in *Pyrotherium*. In one Field Museum specimen it is beneath P_4 and in another under the anterior root of M_1; an additional mental foramen may or may not be present.

AFFINITIES.—Anthony, in his description of *Griphodon*, very briefly stated that the animal was probably a perissodactyl. The only other published opinions that I know of are those of Steinmann (1929, p. 433), Kraglievich (1932B, p. 323) and Simpson (1935, p. 21) who expressed belief that the animal was a pyrothere. With these I am in complete agreement.

When compared with *Pyrotherium*, *Griphodon* exhibits the following differences: (1) P_3 with external longitudinal crest connecting lophids; (2) a swelling on external half of anterior slope of metalophid in P_4, M_1 and dm_4 (evidently a remnant of the external longitudinal crest); (3) P_4 with prominent anterior cusp; (4) anterior and posterior lophids of approximately equal width; (5) cheek teeth longer antero-posteriorly and narrower transversely; (6) lophids and posterior cingula lower and less compressed antero-posteriorly [in part a corollary of (5)]. These are such as would be expected between earlier and later members of a family. (2), (4), (5) and (6) are shared with M_2 (?) of *Carolozittelia*. *Griphodon* is advanced over the Casamayor genus in (1) larger size; (2) lophids slightly more transverse; (3) metalophids higher and rather wider. It is similar to *Propyrotherium saxeum* of the Musters (Ameghino, 1901, p. 387; 1906, Fig. 156, p. 330), a form known from very scanty remains. The lower cheek tooth of this species figured by Ameghino is slightly smaller than M_1 of *G. peruvianus* and appears to have borne a crest on the internal side of the posterior slope of the protolophid, a structure lacking in the Peruvian form. The posterior cingulum, judging from Ameghino's figure, is smaller in *P. saxeum*. I take this tooth to be M_1 or M_2; it is unlikely that it is P_4.

There can, I think, be no doubt that *Griphodon* is a pyrothere. A general similarity to various groups possessing lophiodont cheek teeth does, of course, exist, but the known parts display no character that would warrant exclusion from the Pyrotheriidae[1] and do show positive resemblances to the known members of this family. In evolutionary status *Griphodon* is closest to the Musters genus.

Griphodon enjoys the double distinction of being the only Tertiary mammal known from Peru and the only pyrothere yet discovered outside of Patagonia.

AGE OF *G. peruvianus*.—The specimen is clearly more advanced than *Carolozittelia* of the early Eocene Casamayor, less advanced than *Pyrotherium* of the (approximately) late mid-Oligocene Deseado. Adequate comparison with *Propyrotherium* of the mid-Eocene Musters is difficult, due to inadequate knowledge of *P. saxeum*, but I am inclined to think that *Griphodon* is slightly the more advanced of the two. This suggests, providing that we are dealing with an animal that is neither precociously specialized nor a primitive survivor, that the horizon in which it was found may be rather later than the Musters. Further work at the locality should yield interesting results. I have previously noted (1937, p. 299) that a major gap exists in the Argentinian sequence between the Musters and the Deseado. It is possible that knowledge of the "*Griphodon* fauna" may fill this to some extent.

Steinmann's statement (1929, p. 438) that the close resemblance of *Griphodon* to *Pyrotherium* indicated its Miocene age is doubly erroneous. In the first place the resemblance is far from being so close as to indicate contemporaneity, and in the second, the Deseado is not Miocene but Oligocene in age. On the basis of his assumption Steinmann made the unwarranted correlation of the *Griphodon* horizon with the Venezuelan beds containing *Xenastrapotherium christi*.

MEASUREMENTS IN MM.

	P_3	P_4	M_1	dm_4
L	—	29.5	32.2	29.3
W. ant. lophid	—	19.0	25.8	21.0
W. post. "	16	21.5	25.5	22.0

[1] Simpson (1934, p. 20) is followed in uniting the Carolozitteliidae with the Pyrotheriidae.

BEARING OF *GRIPHODON* AND *P. BORDASI* ON CORRELATION

Until quite recently almost nothing was known of the geology of eastern Peru and southwestern Brazil. Within the past twenty years, however, reconnaissance work has laid the groundwork for an understanding of part of it. Investigations by Singewald (1927, 1928) at the Pongo de Manseriche (the canyon cut through the Cordillera Oriental by the Marañon) and along the Pichis and Pachitea rivers, tributary to the Ucayali, and by Oppenheim (1937) along the upper Juruá and middle Ucayali have revealed a remarkably uniform rock succession throughout this immense region (see table at end of this paper). In addition to the areas just mentioned, the Red Beds Series is extensively exposed along the Río Huallaga and is apparently met with as far north as the Río Napo in Ecuador (Singewald, 1927, pp. 489–490). With the exception of the "Younger Tertiary" at the Pongo de Manseriche, the four major groups of strata appear to be conformable; all were involved in the orogenic movements of the Cordillera Oriental.

No fossils have been found in the Pongo and Môa Sandstones. The Shale Limestone Series yielded fossils in relative abundance, ranging from Albian at the base to Coniacian (basal Senonian) at the top. Marine invertebrates were found near the base and fresh water shells in the upper part of the Red Beds Series. According to determinations by Pilsbry (Singewald, 1928, p. 463), the former are of late Cretaceous age and the latter of late Tertiary (Miocene or Pliocene) aspect. Deposition of the Red Beds, therefore, must have begun in the late Cretaceous and continued until well into the Neogene, the sedimentation changing from marine to continental.[1] Singewald found no fossils in his Brown Beds Series, but Oppenheim collected crocodilian remains at Aquidabam, 50 km. below São Felipe on the middle Juruá, in beds immediately overlying the Cruzeiro Red Beds. The deposit evidently corresponds to the base of Singewald's Brown Beds. The crocodiles have been determined by Roxo (1937A, p. 4; 1937B, p. 10) as *Caiman?*, *Gryposuchus* and *Dinosuchus*.[2] Oppenheim believes that they indicate Pliocene age, and that the underlying Red Beds can hardly be younger than Miocene. Singewald on the other hand is of the opinion (1937, p. 1349) that the Brown Beds are "probably mainly Miocene" but may extend into the Pliocene. The age of this series is of considerable interest since it has an important bearing on the date of the Eastern Cordilleran orogeny, a question upon which *Phoberomys bordasi* has some bearing.

Griphodon and *P. bordasi* can now be placed in this eastern Peruvian–southwestern Brazilian sequence, the former tentatively, the latter with rather more assurance. *Griphodon peruvianus* was certainly found in the Red Beds Series, although the exact, or even the approximate, position of its horizon within the series is unknown. *A priori*, however, this should be somewhere within the upper half. In any event the important fact that the series contains a fossil suggesting an age close to Musters can be recorded.

Phoberomys bordasi is a member of a genus found elsewhere only at Paraná and was collected together with a specimen of *Dinosuchus terror*. This crocodilian, and others of Paraná aspect, have been found at various localities in the southwestern part of the Amazon basin. At one of these, Aquidabam, such crocodilians were found in a deposit immediately overlying the Red Beds Series and corresponding to the base of the Brown Beds Series. From these facts it may be concluded with a fair degree of certainty that the *P. bordasi* horizon is at or near the base of the Brown Beds, and that deposition of the series began in or near Paraná, late Miocene, time.

This suggests comparison of the Brown Beds with the Araucanian Series, as exposed in Catamarca, Argentina, which also begins with a Paraná equivalent and which was also involved in orogenic movements (Riggs and Patterson, 1939). The youngest Araucanian formation recognized

[1] Various authors, Steinmann, Moran and Fyfe and Oppenheim, have correlated the Red Beds Series with Steinmann's Puca Formation. This seems quite unjustifiable. Fritzsche's work (1924) on fossils from various Puca localities shows that all are Cretaceous, many of them of early Cretaceous aspect.

[2] Roxo believes (1937A, p. 5) that they are Pleistocene, a view which is surely incorrect.

TABLE SHOWING ROCK SUCCESSION IN EASTERN PERU AND SOUTHWESTERN BRAZIL, THE AGES OF THE STRATIGRAPHIC UNITS DESCRIBED AND THE PROBABLE CORRELATION WITH THE STANDARD TERTIARY SEQUENCE OF ARGENTINA

Pongo de Manseriche (Singewald, 1927)	Pichis and Paqhitea rivers (Singewald, 1928)	Juruá and Ucayali rivers (Oppenheim, 1927)	Approximate equivalents in Argentinian Tertiary sequence	Age
"Younger Tertiary" 1000 + ft.	Brown Beds 3000 ft.	Aquidabam deposit	Paraná	Mid-Pliocene (?) to late Miocene
Red Beds 4000–8000 ft.	Red Beds ca. 3000 ft.	Cruzeiro Red Beds	*Griphodon* horizon slightly later than, or equivalent to, Musters	Late Miocene to late Cretaceous
Huacanqui Sandstone Shale Limestone Series ca. 3500 ft.	Huacanqui Sandstone Shale Limestone Series	Sungarú Sandstone Shales and Limestones		Coniacian (basal Senonian) to Albian
Pongo Sandstone	Pongo Sandstone	Môa Sandstone		Pre-Albian, possibly extending downward into late Jurassic

by the Second Marshall Field Expedition of Field Museum is the mid-Pliocene Corral Quemado, but younger beds may well be present above this. If, as seems quite possible, the two series are essentially contemporaneous the orogenic movements of the Cordillera Oriental may be dated as at least post-mid-Pliocene.

The relationships are summarized in the accompanying table.

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