Fossil Mammals from the Type Area of the Puerco and Nacimiento Strata, Paleocene of New Mexico

BY GEORGE GAYLORD SIMPSON

ANTECEDENTS

The first American Paleocene mammals and the first anywhere from the early to middle Paleocene were found in the San Juan Basin of New Mexico. Somewhat more complete sequences and larger faunas are now known from elsewhere, but the San Juan Basin strata and faunas are classical and are still the standard of comparison for the most clearly established lower (Puercan), middle (Torrejonian), and upper (Tiffanian) stages and ages.

The first geologist to distinguish clearly what are now known to be Paleocene beds in the San Juan Basin was Cope in 1874. He named them "Puercan marls" (Cope, 1875) on the basis of beds along the upper Río Puerco, and especially of a section west of the Río Puerco southwest of the then settlement of Nacimiento and of the present town of Cuba, on the southern side of Cuba Mesa. Cope reported no fossils other than petrified wood, but in 1880 and later his collector, David Baldwin, found rather abundant mammals, described by Cope (1881 and later) in beds 50 miles and more to the west and northwest of the type locality but referred to the same formation. In the 1890's Wortman collected for the American Museum in the Puerco of Cope, and, on the basis of this work, Matthew (1897) recognized the presence of two quite distinct faunas of different ages. He restricted the name "Puerco" to the older fauna and (supposedly) formation and gave the
name "Torrejon" (for Torrejón or, more properly, Torreón Arroyo; see notes on nomenclature below) to the younger.

Recognizing that the Puerco and Torrejon of Matthew, although so distinct in age and faunas, had not been sufficiently distinguished as rock units, Gardner (1910) proposed to unite them in a Nacimiento group, named for an older settlement that preceded present-day Cuba. Gardner did divide the rocks of his Nacimiento group, at Cope's type locality for the Puerco, into Puerco and Torrejon formations, but his division was arbitrary and, as is shown below, certainly erroneous.

It is still true that no one has been able to separate the Puerco and Torrejon of Matthew, also Sinclair and Granger (1914) and others, on the basis of the strata alone. They are not rock units, but rock-time and biostratigraphic units distinguishable only when and where they have been dated by fossils. In mapping they have been designated as "Puerco and Torrejon undivided," or recently usually as "Nacimiento formation," which is understood to contain the Puerco and Torrejon faunas. These faunas were the basis for the proposal by Wood and others (1941) of Puercan and Torrejonian ages (time units) and corresponding stages (rock-time units, recognizable only on the basis of paleoontological correlation).

In essence, those are the nomenclatural antecedents of the present note. The history, considerably more complicated in detail, has been sufficiently summarized elsewhere (Simpson, 1948).

The fossils collected by Baldwin for Cope were an unseparated mixture of Puercan and Torrejonian species and came from a broad band of intermittent exposures running from Chico Springs to Kimbetoh Arroyo (see Sinclair and Granger, 1914, footnote on p. 310), or quite possibly to the next main arroyo to the east, for which I now propose to use the name "Tsosie" (see below). Granger and his field associates in the 1910's extended the known fossiliferous Torrejonian localities northward across Kutz Canyon and the San Juan-Animas divide, then up the Animas Valley to northeast of Cedar Hill. They and others also extended the known Torrejonian eastward (beyond Tsosie Arroyo) to an easterly tributary of Torrejon (or, as below, Torreón) Arroyo. To this day no one has found identifiable Puercan fossils outside the area covered by Baldwin, from Chico Spring to Tsosie Arroyo, inclusive.

Thus until the present paper there has been a decidedly anomalous situation. The age or ages of the stratigraphic type Puero and type Nacimiento have been unknown, no identifiable fossils have been reported from possibly equivalent strata nearer than about 10 miles west of the type locality, and Puercan fossils have not been reported nearer
than about 50 miles. Now identifiable mammals have been found in Cope's type section of the "Puerco marls" and elsewhere in the vicinity of present Cuba and former Nacimiento. Most of them were found in 1949 by George O. Whitaker and me, with some assistance by Creighton H. Peet, of New York, Gene Garrison of Cuba, and, more casually, others. The purpose of this paper is to describe those finds and to discuss their bearing on nomenclatural and stratigraphic problems. Mrs. Mary B. Patsuris has helped substantially in the work involved.

LOCALITIES, FAUNAL LISTS, AND AGE

Localities are designated by field numbers assigned in Simpson (1949–1950 field book). They are shown on maps and air photographs on file in the American Museum. Only the mammals, at present the only reliable guide fossils, are reported in this paper, but all localities are listed.

LOCALITY 216

Lower part of Nacimiento, level not more exactly determined; middle of east line of sect. 20, T. 21 N., R. 1 W.

Fossils: Leaves, not identified.

LOCALITY 217

Within bottom 50 feet of Nacimiento exposures in SW. ¼ of SE. ¼, sect. 16, T. 21 N., R. 1 W.

Fossils: Fragmentary skeletal bones of at least two species of small mammals; not identifiable, but recorded for possible future collecting and as the first mammals found in the type region of Puerco and Nacimiento.

LOCALITY 218

A few feet below locality 217 and in the same one-sixteenth section.

Fossils: Crocodilian jaw, not identified.

LOCALITIES 219 AND 220

Near middle of south half of sect. 10, T. 21 N., R. 1 W. Summary section as follows (from top to bottom):

---

1 In a note not widely available (Simpson, 1950) I implied that Torrejonian fossils had been found near Cuba. That was based on discoveries more explicitly reported in the present paper.
a. Basal San José sandstone, cross-bedded, weathering yellow, with some intercalations of somber to greenish clays; not measured.

—Erosional disconformity—

b. Nacimiento, rather evenly banded gray and grayish yellow siltstones; a few yellowish gray, lenticular sandstone channels; locality 219 at bottom, in yellowish gray siltstone; 50 feet.

---

Fig. 1. Diagrammatic section of Nacimiento formation at the southeastern point of Cuba Mesa. Thickness measured by aneroid barometer. Details of beds within measured units purely diagrammatic or symbolic. Numbers to right of section indicate levels of fossil localities. None occur exactly in the line of section, but localities 222, 226, 229, and 230 have been traced laterally on continuous exposures. Level of locality 219 has not been traced into section and is a broad approximation based on depth below basal San José. Ojo Alamo sandstone occurs immediately south (to the right) of section, but intervening flat is covered and level shown is an approximate projection. Dip, not shown, is about north 20 degrees west and is variable near line of section, about 2 degrees to 8 degrees, averaging less than 4 degrees.
c. Nacimiento, medium light gray clay at top, locally a good horizon marker; medium light to medium dark gray clays and siltstones, generally more somber than b, and with several thin lignitic or carbonaceous fissile, laminated beds grading to grayish black; numerous lenticular light to yellowish gray channel sands; total thickness exposed here about 85 feet; locality 220 about 20 feet above base of exposure and about 65 feet below a.

**Fossils:** Locality 219: Cf. *Deuterogonodon* sp. indesc.; *Haploconus angustus*; and *Periptychus carinidens*. Locality 220: Chelonian, not identified.

**Localities 221, 222, and 223**

About \( \frac{1}{2} \) to \( \frac{3}{4} \) mile west of southeastern point of Cuba Mesa, in second spur of Nacimiento beds from that point. Levels traced into section (fig. 1) and there indicated. Localities 221, 222, and 223 are on same slope; locality 223 is about 60 feet below 221; and locality 222 is 2–3 feet below locality 223.

**Fossils:** Locality 221: Poorly preserved chelonian, not identified. Locality 222: *Periptychus carinidens*; leaves, not identified. Locality 223: Poorly preserved chelonian, not identified.

**Locality 226**

All in the same stratum, 10 to 15 feet thick, in a continuous stretch of exposures over an area about \( \frac{1}{4} \) mile in diameter, northwest to west-northwest of southeastern tip of Cuba Mesa on fourth main spur projecting southward from the mesa, mainly or wholly in sect. 3, T. 20 N., R. 2 W. Level traced into section (fig. 1) and there shown. Its bottom is about 15 feet above a relatively persistent small lignite seam and its top about 5 feet below a thinner, less persistent, carbonaceous band which is the level of locality 222.

**Fossils:** *Psittacotherium multifragum?; Tricentes subtrigonus; Tetraclenodon puercensis; Haploconus angustus; Periptychus carinidens* and cf. *carinidens*; chelonian, not identified; crocodilian, not identified; and garfish scales.

**Locality 228**

Near eastern line of SE. \( \frac{1}{4} \), sect. 10, T. 20 N., R. 2 W.; same level as locality 230 (see fig. 1).

**Fossils:** Chelonians, not identified.

**Locality 229**

About 1 mile southwest of locality 226 and at same level (see fig. 1).
Fossils: *Periptychus carinidens*; and leaves, not identified.

**Locality 230**

On west side of Chihuila Arroyo, about 2 1/2 to 3 miles west of top of southeastern tip of Cuba Mesa. Level traced into section (fig. 1). Seventy-five to 100 feet below level of locality 226 and 100 to 125 feet above base of type Puerco and Nacimiento.

Fossils: *Haploconus angustus; Periptychus carinidens*; and chelonian, not identified.

**Summary and Age Determination**

Identified mammals of known age are from the following localities and horizons:

North of Cuba: Upper part of Nacimiento, about 50 feet below top of that formation, locality 219.


Each of these localities has at least one mammal identified to species. All the species are known otherwise only from the Torrejonian. All the genera are known otherwise in the Torrejonian, and most of them are confined to that age as far as known. The stated levels at these localities are certainly of Torrejonian age, as are the equivalent levels traced continuously from the fossil localities into the southeastern tip of Cuba Mesa.

**Fossil Mammal Specimens**

*Psittacotherium multifragum?*

**Material:** A.M.N.H. No. 36000; nearly complete skull and partial jaw, but very poorly preserved; locality 226.

**Discussion:** Identification cannot be quite certain because of the poor preservation. Much of the skull is concretionary,¹ and no com-

---

¹ It frequently happens with both Puercan and Torrejonian specimens from the Nacimiento that bone has reacted in some way with the surrounding matrix to produce a hard mass larger than the original bone and forming a sort of blurred, detail-less replica of the latter. This is not a concretionary coating around sound bone, such as occurs so frequently in fossils. When the apparent concretionary mass is dissected mechanically or with acid, no bone is found within, or only slivers. What was formerly the actual bone substance forms the apparent concretion, which is phosphatic as has been determined by Dr. Brian Mason. This reaction does not occur with enamel, so that many specimens from the Nacimiento consist of a gross concretion.
plete tooth is visible. Nevertheless the observable characters are those of *Psittacotherium* and no other known genus, and the size is in the probable range of *P. multifragum*.

*Cf. Deuterogonodon* sp. indesc.

**Material:** A.M.N.H. No. 36001; fragment of left maxilla with P⁴; left upper molar, probably M³ but possibly M², broken on buccal side; internal part of right P⁴; antero-internal part of right upper molar,

![Image of fossil fragments](image)

**Fig. 2.** *Cf. Deuterogonodon* sp. indesc. A.M.N.H. No. 36001. A. Fragment of left maxilla with P⁴. B. Left upper molar, probably M³. C. Anterobuccal part of probable right M⁴. All crown view. All ×2.

probably M² but possibly M³; antero-external part of right upper molar, probably M³; other, uncharacteristic fragments; locality 219.

**Discussion:** These fragments were separate but near one another. They almost certainly represent a single individual, as they are congruent in size and structure, and all represent an animal otherwise unreported from the Nacimiento formation.

*Caricature, so to speak, of jaw or skull with sound and unaltered tooth crowns projecting from it. The reaction is not invariable, and well-preserved bone may be found along with altered specimens.*
P4 has a large internal protocone, almost as large and high as the external cusp (paracone, parametacone, or amphicone of various authors; protocone of Scott). The latter cusp is sharply crested anteroposteriorly, and there is a small metastyle buccal to the posterior crest. (The parastyle region is broken off on both P4's.) The more complete presumed M3 is broad and rounded lingually, with a crenulated or beaded cingulum complete around anterior, lingual, and posterior sides (buccal side broken off). The cingulum rises to form a small but distinct hypocone posterior to the protocone. The anterior wing from the protocone passes anterior to the paracone and bears two cuspules, one anterior to the paracone and one, an apparent protoconule, between that and the protocone. The metaconule is unusually large and is as if displaced posteriorly, on a line from hypocone to metacone. The metacone is prominent but is noticeably smaller than the paracone. The central enamel is only faintly rugose. Another molar fragment, probably of right M3, shows the somewhat crescentic paracone and part of a probably feeble but quite distinct mesostyle.

Fig. 3. *Tricentes subtrigonus*. A.M.N.H. No. 36002. A. Right M3, broken. B. Right M3, broken. All crown view. All ×2.

This animal is evidently an arctocyonid (*sensu lato*), with some resemblance to *Protogonodon* and *Claenodon* (as well as *Neoclaenodon*, if that is distinguished). It is, however, too distinctive to belong to one of those genera as they are currently defined. The characteristic hypocone and metaconule of M3 and probably the presence of a mesostyle suggest *Deuterogonodon montanus* (see Simpson, 1937), but the present specimen can hardly belong to that species. It is considerably smaller, has the inner side of M3 more rounded and expanded anteroposteriorly, and has the hypocone less internal, among other, lesser differences. Closest comparison is with the M3 described as "*Protogonodon?* species" but also compared with *Deuterogonodon* by Gazin (1941) from
Fig. 4. *Tetraclaenodon puercensis*. A.M.N.H. No. 36003, part of right lower jaw with broken \(M_{1-2}\) and complete \(M_3\). A. Crown view. B. External view. C. Internal view. All \(\times 2\).
the Wagonroad fauna of Utah. On available information, the two could well belong to the same species, but the information is deficient. The Wagonroad form is almost surely much older and is quite unlikely to be conspecific with ours.

Although the specimen is inadequate for definition, it seems to represent an unnamed species close, if not actually belonging, to *Deuterogonodon*.

*Tricentes subtrigonus*

**Material:** A.M.N.H. No. 36002; right M² and M³, each broken anterobuccally; fragment of internal part of left M²; locality 226.

**Discussion:** Although separated as found, these teeth surely belong to one individual. M² is not exactly measureable, but is about 61 2 mm. long and 81 2 mm. wide. That is small for *Tricentes subtrigonus*, but probably within the range of that species, with which the teeth agree closely in structure.

*Tetraclaenodon puercensis*

**Material:** A.M.N.H. No. 36003; part of right lower jaw with broken M₁₋₂ and complete M₃; locality 226.

**Discussion:** This specimen is in all respects within the known range of *Tetraclaenodon puercensis*, an abundant Torrejonian guide fossil. Measurements are given in table 1.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurements (in Millimeters) of Teeth of Tetraclaenodon puercensis</strong></td>
</tr>
<tr>
<td>(A.M.N.H. No. 36003) from the Cuba Region</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>M₁</td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Width</td>
</tr>
</tbody>
</table>

*Haploconus angustus*

**Material:** A.M.N.H. No. 36004; left P³–M²; M¹ broken; locality 219. A.M.N.H. No. 36005; right C, P₃₋₄, M₂; left C, P₂₋₄, M₂₋₃; locality 219. A.M.N.H. No. 36006; partial lower jaw with left P₂, P₄, and M₃; locality 226. A.M.N.H. No. 36007; much of lower jaw with right P₂–M₃ (M₂ broken) and left P₂–₃ and M₃; locality 226. A.M.N.H. No. 36008; parts of nine separate upper and lower teeth and jaw fragments, from two or
Fig. 5. *Haploconus angustus*. A, B. A.M.N.H. No. 36007, lower jaw with right P₄-M₄ (M₂ broken) and left P₂-₃ and M₄. A. Crown view. B. Right external view. ×2. C. A.M.N.H. No. 36004, left P¹-M¹ (M¹ broken). Crown view. ×3.
TABLE 2

Measurements (in Millimeters) of Upper Teeth of *Haploconus angustus* from the Cuba Region

<table>
<thead>
<tr>
<th></th>
<th>P^4</th>
<th>M^1</th>
<th>L</th>
<th>W</th>
<th>L</th>
<th>W</th>
<th>M^3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M.N.H. No. 36004</td>
<td>5.0</td>
<td>6.4</td>
<td>—</td>
<td>—</td>
<td>4.2</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>A.M.N.H. No. 36008a</td>
<td>5.7</td>
<td>6.6</td>
<td>—</td>
<td>—</td>
<td>4.1</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>A.M.N.H. No. 36010</td>
<td>5.2</td>
<td>6.1</td>
<td>—</td>
<td>—</td>
<td>4.8</td>
<td>6.7</td>
<td></td>
</tr>
</tbody>
</table>

* Probably two or more individuals.

more individuals; locality 226. A.M.N.H. No. 36009; jaw fragments of one individual with right P₃, M₂-₃, and left broken M₃; locality 230. A.M.N.H. No. 36010; poorly preserved separate upper premolar and molar, with numerous unassociated fragments; locality 230.

**Discussion:** All the comparatively numerous small periptychids in the collection belong to *Haploconus*, with the possible exception of a few virtually unidentifiable scraps. The measurements given in tables 2 and 3 are mostly within the established range of *H. angustus*. The

TABLE 3

Measurements (in Millimeters) of Lower Teeth of *Haploconus angustus* from the Cuba Region

<table>
<thead>
<tr>
<th></th>
<th>P₃</th>
<th>P₁</th>
<th>P₄</th>
<th>M₁</th>
<th>M₂</th>
<th>M₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.M.N.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 36007</td>
<td>4.8</td>
<td>2.8</td>
<td>6.0</td>
<td>3.6</td>
<td>5.5</td>
<td>4.0</td>
</tr>
<tr>
<td>A.M.N.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 36008a</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>6.0</td>
<td>4.3</td>
</tr>
<tr>
<td>A.M.N.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 36005 ca. 4½</td>
<td>3.0</td>
<td>5.6</td>
<td>3.9</td>
<td>5.3</td>
<td>3.9</td>
<td>—</td>
</tr>
<tr>
<td>A.M.N.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 36009</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>4.5</td>
</tr>
<tr>
<td>A.M.N.H.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 36006</td>
<td>5.3</td>
<td>2.7</td>
<td>—</td>
<td>6.0</td>
<td>3.9</td>
<td>—</td>
</tr>
</tbody>
</table>

* Probably two or more individuals.
largest specimens are near *H. corniculatus* in size, but it is probable that all are variants of *H. angustus*. In any case, the separation of the two supposed species is not satisfactory at present.

*Periptychus carinidens*


**Discussion:** Cope named two species now referred to *Periptychus*: *P. carinidens* and *P. rhabdodon*. The distinctions given by Cope, believed by him to be generic, are invalid because based on comparison of deciduous teeth, not recognized as such, with permanent teeth. Matthew (1937) corrected that error but retained both species, defining them on slight differences of size and proportions of the teeth. I have measured and compared 37 specimens in the American Museum collections, all from the classical Torrejonian localities (although only one from the type section of the Torrejon), with permanent lower molars. Most of them were in the Cope Collection, but some were added by parties under Wortman and Granger. The distributions of cheek tooth dimensions (lengths and widths of P₄–M₃) are flat, with higher variation than might be expected in a single local population. Nevertheless none shows or even suggests definite bimodality, and distributions of specimens referred by Cope and by Matthew to *P. carinidens* and *P. rhabdodon* intergrade and overlap widely.

It is, indeed, probable that more than one population is represented. The area is no larger than could well be occupied by one deme of animals of this size, and known associations do not indicate ecological differences, but the time span covered is certainly considerable and could involve both progressive change and geographic shifts in distribution of taxa. That hypothesis cannot be tested with these materials, as most of them are without useful locality and horizon data (beyond the assurance that all are Torrejonian in the Nacimiento formation), and
there is no adequate sample of animals known to be from one level. On data now available there is no possible objective way of dividing this large suite of specimens into valid species or lesser taxa. There is,
then, no proper alternative to placing all in a single species, the prior and valid name of which is *Periptychus carinidens* Cope, 1881.

As shown in table 4, four of our five specimens with measurable

| TABLE 4 |
|-----------------|---|---|---|---|---|
| Measurements (in Millimeters) of Teeth of *Periptychus carinidens* from the Cuba Region, Compared with Observed Range of Teeth Previously Found Elsewhere in the San Juan Basin |
| | P₄ | M₀ | M₂ | M₄ |
| | L | W | L | W | L | W | L | W |
| Previous sample |
| Number | 19 | 21 | 28 | 29 | 36 | 36 | 27 | 28 |
| Observed range | 11.1– | 8.5– | 9.9– | 7.2– | 8.7– | 8.0– | 10.4– | 7.3– |
| Cuba region |
| A.M.N.H. No. 36018 | 12.2 | 10.5 | — | — | 9.5 | 9.6 | — | — |
| A.M.N.H. No. 36016 | — | — | 10.0 | 7.9 | 8.0 | 8.4 | — | 8.1 |
| A.M.N.H. No. 36014 | 12.1 | — | — | 10.3 | — | ca. 12 | — | 8.4 |
| A.M.N.H. No. 36015 | 11.7 | 9.6 | ca. 10 | — | ca. 9½ | — | 10.6 | 7.7 |
| A.M.N.H. No. 36011 | — | — | 11.6 | 9.7 | — | — | — | — |

lower molars from the Cuba region are entirely within the observed range of earlier collections of *P. carinidens* from the classical localities to the west and northwest. A.M.N.H. No. 36016, from locality 226, has the length of M₂ distinctly below that range, and, although the comparison is not made in the table, the ratio of length to width is also definitely smaller than in the series used for comparison. In two of the latter specimens, the width of M₂ slightly exceeds the length, but not to this degree. Other measurements and proportions of A.M.N.H. No. 36016 are within the established range of *P. carinidens*, and two other good specimens from the same horizon and locality are entirely in that range. It is highly improbable that two (or more) such closely similar taxa occur together here. A.M.N.H. No. 36016 is listed as *P. cf. carinidens* but is probably from the same population as the specimens placed in *P. carinidens* from the same locality. That population may have been distinguishable, at a subspecific level at least, from more
nearly topotypical *P. carinidens*, but the data do not establish this with sufficient probability.

**STRATIGRAPHIC BEARINGS**

**AGE AND LIMITS OF THE PUERCO MARLS OFCOPE**

Cope (1875) noted the presence of his "Puerco marls" in the valley of the Río Puerco both above and below Nacimiento (an old settlement near the present Cuba), but emphasized an "escarpment of 500 feet elevation facing the south" at a point on the Río Puerco about 6 miles below Nacimiento. This is certainly the high southeastern point of the elevation now called Cuba Mesa, and that may be taken as the restricted type locality of the Puerco of Cope. The sandstones capping the mesa at that locality were excluded, at least by implication. The lower limit was not identified by Cope, who included in the Puerco (with doubt in some instances) beds to both the north and the south that are now known to be Cretaceous.

Gardner (1910) published a section taken essentially at and southward from the restricted type locality. No fossils were found in or near this section, which was, nevertheless, divided by Gardner into Puerco and Torrejon formations. A summary of this section, subdivided for purposes of present discussion, is as follows:

"Wasatch"
(Unconformity)
"Torrejon":
  a. Alternating shales and sandstones, predominantly sandstone; 276 feet
(Unconformity)
"Puerco":
  b. Mainly shales, some lenticular sandstones; 379 feet
c. Massive coarse sandstone; 40 feet
d. Shale and soft sandstone with local coal; 139 feet
(Unconformity)
Lewis shale

Sinclair and Granger (1914) correlated unit *c* of Gardner's section

---

1 The distance from present Cuba is only 4 miles, but Nacimiento was about 2 miles from the site of Cuba and in the opposite direction (see last section of this paper). Most of Cope's distances relating to his expedition of 1874 are overestimated, but this one is almost exact.

2 The unit designated *c* in my summary of Gardner's section; not so labeled by Gardner.
with a sandstone immediately below the lower fossil level of the Torrejon in Torrejon Arroyo. Dane (1932) showed (and we have confirmed) that c of Gardner's section is certainly the Ojo Alamo sandstone, Cretaceous in age. Unit d of Gardner's "Puercan" is, of course, also Cretaceous and is the Kirtland or Kirtland and Fruitland undivided\(^1\) of present nomenclature. Gardner's "Torrejon" is the basal San José (see further below), and his b alone is the whole of the Paleocene at this locality, its thickness grossly underestimated by Gardner.

If Sinclair and Granger's correlations were correct, then the level in the type section equivalent to the lowest Torrejon fossil level of Torrejon Arroyo would be immediately above the Ojo Alamo. The whole of Cope's type Puerco would therefore be Torrejonian (or later) in age, and none of it Puercan. However, as Dane (1932) further showed, that correlation is not correct. Dane estimated that the lower (Torrejonian) fossil level of Torrejon Arroyo is about 450 feet above the Ojo Alamo. The equivalent level in Cope's type Puerco was not exactly identified, but would certainly also be far above the Ojo Alamo. Dane therefore concluded that beds Puercan in age (as we would now put the matter) could well occur in the unfossiliferous lower part of the type Puerco.

Our lowest guide fossils (locality 250) are only 100 to 125 feet above the Ojo Alamo. These fossils are definitely Torrejonian. The thickness in which Puercan strata might be present is thus, on present evidence, much less than was indicated by data available to Dane. In the Ojo Alamo to Tsosie Arroyo region, where both Puercan and Torrejonian fossils occur, the highest Puercan fossils are not over 100 feet above the Ojo Alamo sandstone (76 feet in Sinclair and Granger's Ojo Alamo section). The lowest Torrejonian fossils in that region (in Sinclair and Granger's Ojo Alamo section) are about 245 feet above the Ojo Alamo, and the level is still higher in the Kimbetoh and Tsosie drainages.

It follows that it is still possible that strata of Puercan age occur in the lower 100 feet, more or less, of the type Puerco, but not significantly higher. There is, however, no reliable evidence, even indirect, to that effect, and our discovery of Torrejonian fossils at a level so far down in that section has definitely reduced the probability that any of it is Puercan in age.

As for the upper part of the type Puerco, at our locality 219 there are Torrejonian fossils only 50 feet below the basal San José sandstones.

---

\(^1\) Kirtland and Fruitland have not been distinguished here, and opinions differ as to whether the Fruitland has pinched out or has simply become indistinguishable from the Kirtland as both thin to the eastward. The latter is my tentative opinion.
It is thus extremely unlikely that any beds below those sandstones are here post-Torrejonian in age.

Puerco and Puercan

When Matthew (1897) divided Cope's Puerco into Puerco and Torrejon formations, this seemed a legitimate restriction of Cope's Puerco to a part, only, of the type section. On that basis, the usage has been followed by almost all later authors. We now see, however, that much the greater part, at least five-sixths, of Cope's Puerco belongs to Matthew's Torrejon and that there is no evidence that the Puerco formation of Matthew occurs at all in the type section of the Puerco. However, the Puerco fauna (rather than formation) in the sense of Matthew (not Cope) has been universally known under that name by paleontologists everywhere for two generations. No other name is in use. Puercan for the earliest Paleocene age and stage of western United States (Wood *et al.*, 1941) has been generally adopted.

Of various possible solutions to this dilemma only one seems really sensible. "Puerco" should be abandoned as a rock name ("Puerco formation," etc.). "Puerco fauna" is still useful and now unambiguous for the oldest fossils of the Nacimiento formation, and "Puercan" for the age during which that fauna lived. If it should ever become possible to distinguish clearly a lower lithologic unit at least partly of Puercan age within the Nacimiento formation, a new name should be given to it.

The same problem does not arise with respect to the name "Torrejon," because the type section in Torrejon Arroyo is indeed largely if not entirely characterized by the Torrejon local fauna and Torrejonian in age. However, the Torrejon has never been and is not now clearly defined as a rock unit, and as of now there is no recognized or mappable Torrejon formation. The name would become available and appropriate if a subordinate, relatively high rock unit wholly or partly of Torrejonian age were properly defined within the Nacimiento.

The Nacimiento Formation

Gardner (1910) specified the section west of the Río Puerco south and west of Cuba ("Nacimiento") as the type of his Nacimiento group. His section was evidently taken southward from the southeastern tip of Cuba Mesa, which is also essentially the restricted type locality of Cope's Puerco. As noted above and as first pointed out by Dane (1932), Gardner's type section of his Nacimiento group actually includes the basal San José, Ojo Alamo, Kirtland (also Fruitland, if present), as well as the Puerco of Cope or Puerco and Torrejon undivided of various
authors. Moreover, the thickness he gives for the part of the section that really is the "Puerco and Torrejon undivided" is widely discrepant, only 379 feet, whereas an apparently exactly measured section made for Dane by C. B. Hunt at this locality gives a thickness of 633 feet 4 inches, and my cruder (aneroid) measurement is approximately 600 feet.

In spite of these discrepancies, Gardner explicitly stated that the name "Nacimiento group" was proposed for the Puerco and Torrejon, collectively, of Matthew. That usage, rather than the erroneous limits and thicknesses of his section, may be accepted. Because the Nacimiento does not now contain any defined subordinate rock units, it may better be called a formation than a group. That different parts of the formation are of distinctly different ages is not now considered pertinent to its status as a rock, not time-rock, unit (e.g., Dunbar and Rodgers, 1957, and their citations).

THE BASAL SAN JOSÉ

The heavy sandstones capping Cuba Mesa, prominent also immediately northwest of Cuba and at places out into the San Juan Basin, have been generally considered the basal part of "Wasatch" of earlier authors, now designated the San José formation (e.g., Reeside, 1924; Simpson, 1948). They contain a considerable amount of intercalated clay and siltstone (the amount of which may be casually underestimated because of the better exposure of the sandstones) and seem to grade without definite break into the overlying, more fine-grained San José. It should, nevertheless, be noted that their age is not definitely established. Almost immediately overlying beds are positively known to be of early Eocene age. The present paper demonstrates with high probability that the immediately underlying beds are of middle, not late, Paleocene age. No diagnostic fossils have been found in these sandstones themselves, and that they belong in the late Paleocene, although improbable, is not impossible.

NOTES ON SOME GEOGRAPHIC NAMES

As in other sparsely settled regions, some confusion has arisen from the evanescence of early geographic names and the absence of settled usage or orthography before detailed maps are made. The following notes may help to clarify some names important as collecting localities and stratigraphic types in the New Mexican Paleocene.
Coots, or Kutz, Canyon

Granger (1917) gave the name “Coots Cañon” to the spectacular basin of badlands northwest of Huerfano Mesa, where he was the first to find (Torrejonian) fossils and where R. W. Wilson (1951) has since discovered a rich and unusual faunule. The now generally accepted spelling, as used by Wilson, is “Kutz” Canyon. (This is also the accepted name for a commercially important natural gas field here.)

Nameless, Eduardo, Bitonitsoseh, or Tsosie Arroyo

Sinclair and Granger spoke of “extensive badlands on nameless arroyo between Kimbetoh Arroyo and Escavada Wash.” Later collectors or discussants have sometimes used the term “Nameless Arroyo” as if it were a name. When I collected there in 1929 I was given the alternative Spanish-American and Navajo names “Eduardo” and “Bitonitsoseh” (an arbitrary spelling of my hearing of the word; see Simpson, 1936). In 1958 a Navajo family (named Tso) resident in the arroyo recognized “Bitonitsoseh” but preferred “Tsosie” (their spelling; their pronunciation is “só-see”; this is probably the word for “narrow” written “tsö’si” by the Indian Service.) We propose to use “Tsosie Arroyo,” as this is a simple and specific name in current use and understood locally. Tsosie Arroyo is the richest locality for the lower Puercan fossil level of the Nacimiento.

Kimbetoh, Ginnibetoh, or Kinnebetoh Arroyo

Another rich lower Puercan locality was called “Kimbetoh Arroyo” by Sinclair and Granger (1914), and that was also the local pronunciation and spelling of the then well-known trading post and arroyo when I first worked there (see Simpson, 1936). In the last few years, however, variants, including “Ginnebetoh,” “Kinnebetoh,” and several others, have been used locally by petroleum exploration parties and others and are beginning to appear on sign posts and maps. These names are, indeed, somewhat closer to the Navajo original, which means “sparrowhawk spring,” but, for the present at least, we propose to retain “Kimbetoh.” That is the only form in the paleontological literature, and the recent variants are not standardized and still do not well represent the difficult Navajo name.

Torrejón, or Torreón, Arroyo

Matthew (1897) applied the name “Torrejon,” for Torrejón Arroyo, to the later beds and fauna of Cope’s Puerco when these were first dis-
tinguished from the earlier beds and fauna, the restricted “Puerco” of Matthew. This usage has become universal among paleontologists, and the name has also been incorporated in the generally used term “Torrejonian” for an age and stage. Nevertheless the name, well known to non-paleontologists also because of application to a trading post and an Indian school, is always spelled and pronounced “Torreón” by the local inhabitants. “Torrejón” (also a correct but not strictly synonymous Spanish word) is probably an error, but it would be quixotic to abandon it now in paleontological usage.

NACIMIENTO, OR CUBA

The earliest settlement on the upper Río Puerco was called “Nacimiento,” for “Nacimiento del Río Puerco” (“origin of the Muddy River”), and Gardner used this name for the Nacimiento group or formation. Gardner and others have considered “Cuba” simply as a modern renaming of “Nacimiento,” but that is not quite correct. Nacimiento was 2 or 3 miles north and east of the present town of Cuba, which has, however, entirely replaced it as a trading center and (still unincorporated) town. As far as I know, the name “Nacimiento,” for a village or inhabited place, appears on no recent maps, but it is still used as distinct from Cuba by some of the older Spanish-American residents. It never had a fixed point or boundaries, but Nacimiento, strictly speaking, probably was not on the Nacimiento formation, and it was farther than Cuba from the section designated by Gardner as the stratigraphically typical Nacimiento. It would, of course, be folly to abandon the well-established stratigraphic name on that account.

REFERENCES

COPE, E. D.

DANE, C. H.

DUNBAR, C. O., AND J. RODGERS
GARDNER, J. H.

GAZIN, C. L.

GRANGER, W.

MATTHEW, W. D.

Reeside, J. B., Jr.

SIMPSON, G. G.

SINCLAIR, W. J., AND W. GRANGER

Wilson, R. W.