set the observed magnetic anomalies, which cut across the steep gravity gradients, if the movement occurred after the emplacement of the intrusive body. Therefore transcurrent movement appears unlikely as an explanation of the abrupt increase in the thickness of the crust.

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Fossil Mammals from Baja California: New Evidence on Early Tertiary Migrations

Abstract. *Ungulates belonging to the family Barylambdidae were found in the same geologic unit with, but stratigraphically above, a specimen assigned to the Tillodontia and above several molars of the perissodactyl cf.* Hyracotherium *sp. This arrangement is unusual, as in the well-documented faunas from the Rocky Mountain Region Barylambdidae are known only from the Paleocene, Tillodontia from the Paleocene and Eocene, while* Hyracotherium *is known only from the Eocene. The expected stratigraphic order would be, from lowest to highest, Barylambdidae, Tillodontia, and* Hyracotherium. *It is suggested that the Baja California assemblage is late Paleocene on the basis of the generalized molars of cf.* Hyracotherium *sp. and the characters of cf.* Esthonyx *sp.*

Paleocene terrestrial mammals are extremely rare in North America west of the Rocky Mountains. A few specimens have been found in the Goler Formation of southeastern California (*1*) but, while some represent new taxa, all greatly resemble Rocky Mountain faunal elements and, at least in the light of present knowledge, there is nothing unusual from a biochronological aspect about the Goler assemblage.

During the summer of 1965 early Tertiary mammals were discovered on the Pacific side of Baja California, approximately 400 kilometers south of Ensenada near the small village of Punta Prieta (29°N, 114°W) (Fig. 1). The first specimen was collected by S. Applegate and H. Garbani of the Los Angeles County Museum of Natural History; later, I collected additional material (*2*). So far the Punta Prieta locality has yielded only four identifiable specimens. Fortunately, however, the taxa represented are of considerable significance from a paleoecological and taxonomic aspect.

Paleontologic studies provide a very practical and necessary geochronology based upon geographic as well as stratigraphic distribution of fossil faunas and floras. A valid geochronology based upon assemblages of fossil organisms presupposes that the assemblages will occur in a readily defined sequence and that each one within the sequence serves to mark a time interval or horizon. These requirements are rather easily met within a small geographic area and when a large time interval is involved, but when the assemblage is correlated regionally the problem of similarity of faunal sequences and synchroneity of faunas is compounded. Extinction, migration, and environmental change can cause any one faunal assemblage to change gradually, both geographically and temporally. The fossil assemblages of widely separated geologic sections would show these changes.

Increased stratigraphic precision demands a time framework consisting of smaller and smaller intervals. The smaller the interval the more probable it is that the assemblage lacks time synchroneity. The amount of time necessary for migration throughout its lateral extent will cause elements of the assemblage to transgress time when the interval measured is short, and in widely separated areas the same taxon is not necessarily synchronous.

Discovery of new localities for critical biochronological guide fossils extends the geographic areas in which these fossils may be used for correlation. Extending the temporal range of critical guide fossils into areas beyond localities where they were previously recognized permits evaluation of the amount of temporal transgression.

The four specimens reported here are significant in adding to knowledge of geographical extent and temporal significance of standard Paleocene terrestrial faunas of the Rocky Mountain area. Provincial ages based upon faunal assemblages and guide fossils pertinent to this discussion are shown in Table 1.

A brief taxonomic and descriptive summary of the specimens from Punta Prieta is as follows.

Order: Pantodonta
Family: Barylambdidae
  1) Scapula
  2) Partial skeleton including skull
Order: Tillodontia
Genus: cf. *Esthonyx* sp.
  3) Several poorly preserved upper and lower molars, premolars, and associated incisors
Order: Perissodactyla
Genus: cf. *Hyracotherium* sp.
  4) Several upper molars

Hyracotherium is perhaps the most well-known taxon from Punta Prieta. Prior to the discovery of the Baja material, this genus was restricted to the Wasatchian of North America and the Sparnacian of Europe (*3*). The genus *Esthonyx* ranges from the Clarkforkian through the Wasatchian in North America (*4*); in addition one form, *E. munieri*, has been reported from the Sparnacian or Cuisian of France (*5*). The Baja California specimen resembles most closely the Clarkforkian forms from the Rocky Mountain area (*6*).

Remains of two individuals referable to the pantodont family Barylambdidae were found at Punta Prieta. Numerous specimens of these creatures have been found in strata deposited during the latest Paleocene in the Rocky Mountain area and in the early Eocene of Mongolia (*7*).

At the Punta Prieta locality, the barylambdids, cf. *Esthonyx* sp., and cf. *Hyracotherium* sp. were found in an outcrop of terrestrial variegated strata within locally developed badlands. Laterally, the specimens occurred within 300 meters of each other while the total stratigraphic separation was not more than 23 meters. Within this stratigraphic interval the two barylambdid specimens were found above cf. *Hyracotherium* sp.; this perissodactyl in turn occurred above cf. *Esthonyx* sp. Stratigraphic displacement of the specimens after death can be ruled out on the basis of their fragile nature, occurrence in well lithified material, and lack of postmortem abrasion.

The age indicated by this peculiar association at first seems to present an unsolvable problem. However, study of morphological differences appears to provide a reasonable solution. The presence of cf. *Hyracotherium* sp. suggests a Wasatchian age, and occurrence of *Esthonyx* does not seem to be in conflict; however, the generalized character of the teeth and their small size place the Punta Prieta material closer to the Clarkforkian faunas of the Rocky Mountains. If this possibility is accepted, then both cf. *Esthonyx* sp. and the barylambdids would be considered late relicts persisting into Eocene time.

The second possibility is to consider the Punta Prieta assemblage to be Tiffanian, based upon the known distribution of the barylambdids in the Rocky Mountains. Acceptance of this solution means that the temporal range of both *Hyracotherium* and *Esthonyx* would be extended.

A third solution is to consider the assemblage Clarkforkian. Although this would cause an extension in range of barylambdids from Tiffanian to Clarkforkian and of *Hyracotherium* from Wasatchian to Paleocene (Clarkforkian), the morphology of the Punta Prieta specimens favors this alternative. The barylambdid is certainly different from Rocky Mountain forms at the specific and, perhaps, generic level. Molars of cf. *Hyracotherium* sp. are very generalized and have characteristics intermediate between certain Paleocene condy-

Table 1. Temporal units and ranges of taxa represented at Punta Prieta.

Epoch	North American ages	European ages	Range of pertinent taxa
	....		
Eocene	....	Cuisian	
	Wasatchian	Sparnacian	*Hyracotherium*
			Esthonyx
	Clarkforkian	Thanetian	
	Tiffanian		Barylambdidae
Paleocene	Torrejonian	Montian	
	....		
	....		

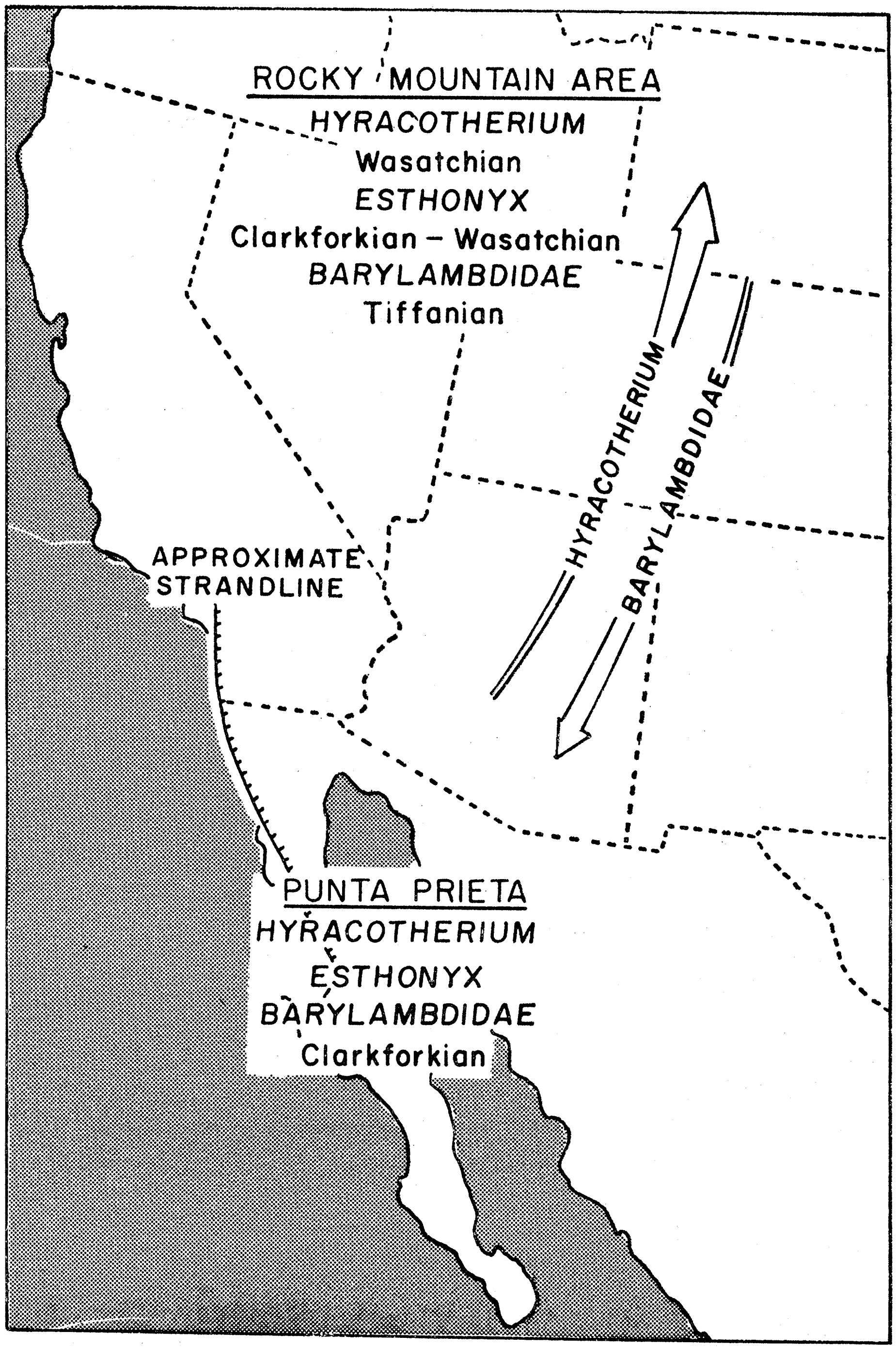

Fig. 1. Distribution and age of early Tertiary mammals from Baja California. Arrows show postulated migration directions of *Hyracotherium* and Barylambdidae during the late Paleocene.

larths and *Hyracotherium* sp. that are described from the Eocene of the Rocky Mountain area and of Europe.

The phylogeny of the equids has been carefully compiled from *Equus* to the Eocene perissodactyl *Hyracotherium*, but the phylogenetic link between the earliest populations of *Hyracotherium* and possible condylarth ancestors has not been found. In fact, the very abrupt Eocene appearance of *Hyracotherium*, even in those areas where Late Paleocene faunas are well known, is disconcerting. This is especially so if the northern origin of *Hyracotherium* is postulated. If, however, perissodactyls on the phylogenetic line leading to *Hyracotherium* evolved in a more southern region and then migrated to North Amerca and Europe, the abrupt stratigraphic appearance in these areas would be a logical consequence. Cf. *Hyracotherium* sp. from Baja California may well be the first discovery supporting such a hypothesis.

Regardless of the age assignment of the Punta Prieta assemblage, though Clarkforkian is at present preferred, the presence of these forms indicates access routes from the Rocky Mountain area to Baja California during early Tertiary time. If the Clarkforkian age assignment proves correct, then migrations along the route were in both directions; barylambdid pantodonts migrating southward while perissodactyls moved north. Occurrence of Early Tertiary notoungulates in South America, Wyoming, and Asia also suggests a north-south migratory route (*8*), but this may have been further east than the one suggested by the Punta Prieta assemblage.

Paleogeographic conditions conducive to north-south migrations are poorly understood. Some workers suggest a direct land connection from southwestern United States through northern Baja California, encompassing the Sierra San Pedro Martir, during the Paleocene and Eocene (*9*). This area would provide a convenient corridor between the Rocky Mountain region and Baja California at least for such seemingly pandemic forms as the barylambdids, *Hyracotherium*, and *Esthonyx*.

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Baffin Island Refugia Older than 54,000 Years

Abstract. *Two radiocarbon determinations on marine shells from the east coast of Baffin Island give ages exceeding 50,000 years. These findings indicate the existence of unglaciated areas (refugia) between fiords occupied by outlet glaciers flowing toward Baffin Bay, from the central part of the Wisconsin ice sheet, over the Foxe Basin–Hudson Bay area.*

The east coast of Baffin Island is generally of steep and rocky fiords, with mountains higher than 1000 m within 10 to 20 km of the coast. A notable exception occurs near Clyde, where the terrain of an approximately 200-km length of the coast rises more gradually, extensive areas lying less than 200 m above sea level in a series of drift-covered forelands; a relatively minor rise in sea level would result in extensive landward displacement of the shore line.

One sample of shell was collected from a raised delta some 15 km inland from the present shore at Cape Aston. In many places the low-lying land slopes gently to the present shore, but elsewhere long stretches of cliffs, up to 40 m high, have been cut in the unconsolidated material. A second sample of shell was taken from such a cliff 17.5 km north-northeast of Clyde.

During the last glaciation the eastern part of Baffin Island was dominated by outlet glaciers flowing toward Baffin Bay along the major valleys and fiords (*1*). The extensive Cockburn moraine system, formed approximately 8000 years ago when the termini of the outlet glaciers lay in the middle parts of the fiords, has been described (*2*), but our knowledge of older glacial deposits is scant.

At the time of the last deglaciation the land was isostatically depressed, relative sea level near the head of the fiords standing more than 70 m higher than at present; the marine limit generally decreased toward the northeast to an altitude of approximately 20 m at the outer coast.

The Cape Aston shells were collected from a sandy part of a large delta at an altitude of 61.3 m; radiocarbon dating (Y-1703) showed an age exceeding 54,000 years (*3*). The sample consisted entirely of *Hiatella arctica* L. and *Mya truncata* L. (*4*); many paired bivalves were found, and few broken shells showed that they were *in situ*.

The delta front is approximately 10 km long and lies parallel with the present shore, while the apex is about 3 km farther to the west. The subaerial part of the delta surface, which is covered with many dry stream beds fanning from the apex, decreases in altitude from 88 m at the apex to 80 m at the rim, where a steep foreslope falls off to 45 m above sea level. Surface material grades from cobbles and small boulders at the apex to sands and gravels at the delta rim. However, boulders more than 2 m in diameter, the largest found on the delta, are scattered along its rim. This distribution pattern shows that the large boulders did not come from the higher parts of the delta; they are interpreted as ice-rafted deposits.

From exposure in numerous small valleys it is apparent that sand is the major material in the delta, in sharp contrast with the surface material. A stratum of silt and clay lies between 60 and 65 m above sea level near the rim, rising toward the apex and forming a distinct structural bench along the valley sides. Shells found in five different localities were all within or immediately adjacent to this stratum of finer sediments. The altitudes of the delta rim and of the marine molluscs show that the delta was formed in salt water at a time when relative sea level was approximately 80 m higher than today.

The delta was deposited in front of large channels, now occupied by notably underfit streams. These channels and the delta must have been formed during a glacial phase when an outlet glacier in McBeth Fiord blocked the normal drainage and chan-