Table 2. Comparison of our determinations (*10*) of $\gamma_{\pm KCl}$ with values from the literature. In parentheses is γ calculated by Eq. 6 and used in integration constant. Our intermediate values of $\gamma_{\pm KCl}$.

Ref.	Molality of KCl solution									
	0.02	0.03	0.05	0.07	0.10	0.20	0.30	0.50	0.70	1.00
					Temperature, 10°C					
10	$.872_0$	$.850_0$	$.819_5$	$.797_5$	$.772_5$	$.720_0$	$.689_0$	$.649_0$	$.623_5$	$.597_5$
*6**	$.872_0$	$.850_5$	$.819_5$	$.797_0$	$.772_0$					
7	.873	.851	.821	.799	.774	.720	.686	.644	.616	.588
8					.769	.718	.687	.648	.623	.598
9†			.817	.795	.769	.717	.686	.648	.623	.598
					Temperature, 18°C					
10	$.870_5$	$.848_5$	$.817_5$	$.795_0$	$.769_5$	$.717_5$	$.687_0$	$.649_0$	$.624_5$	$.601_0$
6†	$.871_0$	$.849_5$	$.818_5$	$.796_5$	$.771_0$					
7	.870	.848	.818	.797	.772	.719	.687	.648	.623	.598
8†					.769	.719	.688	.651	.627	.603
9			.815	.793	.768	.717	.686	.649	.626	.602
					Temperature, 25°C					
10	$.869_0$	$.847_5$	$.816_5$	$.794_5$	$.769_5$	$.718_0$	$.688_0$	$.650_0$	$.626_0$	$.602_0$
5	.868	.846	.816	.794	.769	.718	.687	.649	.626	.603
6	$.870_0$	$.848_0$	$.817_0$	$.794_5$	$.770_0$					
8					.769	.719	.688	.651	.628	.606
9			.813	.792	.767	.716	.686	.649	.626	.604
					Temperature, 38°C					
10	$.866_5$	$.844_0$	$.813_0$	$.790_0$	$.765_5$	$.714_5$	$.685_0$	$.649_0$	$.626_5$	$.603_0$
6†	$.867_0$	$.845_0$	$.813_5$	$.791_0$	$.765_5$					
7	.863	.840	.810	.788	.763	.712	.682	.647	.627	.607
8†					.766	.716	.683	.647	.626	.604
9†			.809	.787	.763	.713	.682	.646	.624	.603
					Temperature, 50°C					
10	$.864_0$	$.841_0$	$.809_0$	$.786_5$	$.761_5$	$.711_5$	$.682_5$	$.647_5$	$.624_5$	$.602_0$
*6**	$.864_0$	$.841_5$	$.810_0$	$.787_0$	$.761_5$					
7	.858	.835	.804	.781	.756	.705	.675	.641	.621	.603
9			.804	.783	.759	.709	.678	.643	.621	.600

Our intermediate values.

Temp. (°C)	Molality				
	0.01	0.015	0.04	0.15	0.40
10	(.9035)	$.886_0$	$.833_5$	$.742_5$	$.666_0$
18	(.9025)	$.884_5$	$.831_5$	$.739_0$	$.665_5$
25	(.9010)	$.883_0$	$.830_5$	$.739_5$	$.666_5$
38	(.8990)	$.881_0$	$.827_0$	$.736_0$	$.664_5$
50	(.8970)	$.878_5$	$.823_5$	$.732_5$	$.662_5$

*Extrapolated. †Interpolated.

differences being as great as 0.005. Caramazza's values tend to be distinctly lower than the others in the molality range 0.05 to 0.2. Calculated values from Lewis and Randall tend to diverge from other values at 38° and 50°C, and at 10°C for molality higher than 0.2. We believe that at 18°C our values for $\gamma_{\pm KCl}$ are probably about 0.001 too low in the molality range 0.05 to 0.3. This belief derives both from comparison with the values of Hornibrook *et al.* and of Lewis and Randall and, more importantly, from the way in which the $\gamma_{\pm KCl}$ change with temperature as a function of molality. For all temperature pairs, except the 18° and 25°C pair, the molality at which the $\gamma_\pm$ become identical is 0.4, or greater; for the 18° and 25°C pair, this molality is 0.09 (Table 2).

Our study is confined to the concentration range 0.01 to 1.0 molal KCl, but we would expect no difficulty in extending the method to higher concentrations. The precision to be expected at molality lower than 0.01 depends mainly on the nature of the particular glass electrode used, including its sensitivity to H^+, and cannot be predicted in the absence of experiment.

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   $$4.5758 \log \gamma = (L_1/T) - 2.303\, \bar{J} \log T + \gamma_{25°C}$$

   Values for $\gamma_{25°C}$ and L_1 and $\bar{J}$ are listed in Lewis and Randall (*5*, p. 643).
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Baja California: Late Cretaceous Dinosaurs

Abstract. *Late Cretaceous dinosaurs have been discovered along the Pacific margin of Baja California. The presence of* Hypacrosaurus *sp. is suggestive of correlation with the Upper Edmonton Formation, Alberta. Dissimilarities between the Baja California fauna and those from contemporary units along the eastern trend of the Rocky Mountains suggest that Baja California was ecologically separated from mainland Mexico during late Campanian and early Maastrictian time.*

The Los Angeles County Museum of Natural History is investigating the early Tertiary and late Cretaceous vertebrate faunas in Baja California (with permission of the Mexican Government). I previously reported newly discovered Paleocene localities (*1*). During the summer of 1966, I collected specimens of late Cretaceous dinosaurs in the vicinity of El Rosario, Baja California (30°N, 115°45′W). The beds containing dinosaur bones extend about 25 km along the Pacific Coast and about 33 km inland along the Arroyo Del Rosario.

The fauna is the only one from the Pacific margin of the continent where dinosaurian materials are abundant. In addition, the similarities and differences

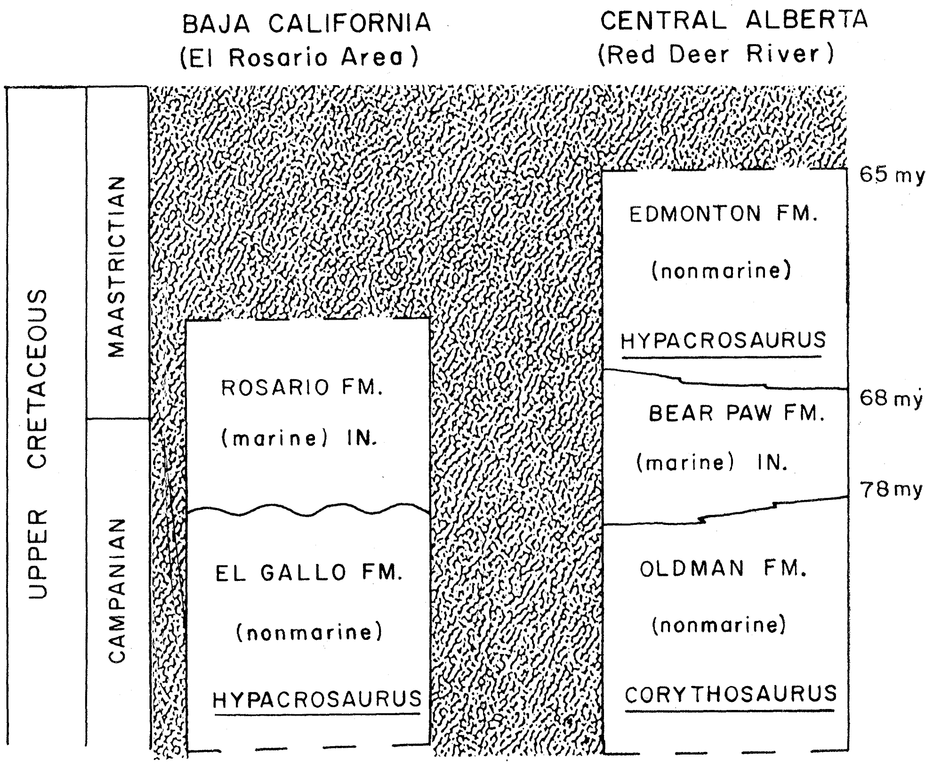

Fig. 1. Stratigraphic summary showing approximate relationships between upper Cretaceous strata of Baja California and Central Alberta. *IN*, formations containing marine invertebrate faunas; *FM*, formation; *my*, million years.

between the dinosaurian fauna of Baja California and those from mainland Mexico and the Rocky Mountain region may provide valuable evidence of the time of geographic isolation of the Baja peninsula.

All Cretaceous strata near the settlement of El Rosario were assigned to the Rosario Formation by Beal (*2*). The unit then included marine as well as nonmarine strata. Assignment by age was not precise, but invertebrate fossils collected in lithologically similar units at Punta Banda and Santa Catarina suggested that the Rosario Formation was upper Cretaceous. Closer inspection of the Cretaceous strata along the Arroyo Del Rosario has shown that the uppermost unit is marine and that this unconformably overlies a thick section of nonmarine and marginal marine deposits. Kilmer (*3*) restricted the name Rosario Formation to the youngest marine strata, designating the unit below the unconformity as the El Gallo Formation. All of the dinosaur material collected was from this formation.

Durham and Allison (*4*) concluded on the basis of benthonic foraminifera and ammonites that the Rosario Formation, as defined by Kilmer, is late Campanian and earliest Maastrictian. If this temporal assignment is valid, the El Gallo Formation and its dinosaurian fauna could not be younger than late Campanian. In addition, a number of invertebrates were collected from a marine lense within the El Gallo Formation and one ammonite fragment was found between successive beds containing dinosaur bones. These fossils uphold the biochronological assignment of the El Gallo Formation as middle to late Campanian (*5*).

Except for the ones discovered in the El Gallo Formation, fossils of dinosaurs are indeed rare along the Pacific margin of the continent. Several fragments and one partial, though poorly preserved, hadrosaurian skeleton have been found in the upper Cretaceous Moreno Formation of northern California. Hadrosaurian foot fragments have been found on at least two occasions near Punta San Ysidro, midway between Ensenada and El Rosario, Baja California (*6*).

The most abundant form found at El Rosario is the very distinctive hadrosaurian, *Hypacrosaurus*. Although the skull is represented by fragments and partial dentaries of several individual dinosaurs, the massively footed ischia and caudal vertebrae with reduced centra proved adequate for recognition of this genus.

The El Rosario *Hypacrosaurus* is certainly one of the largest of the hadrosaurians, rivaled in size only by *Edmontosaurus* from the Canadian Cretaceous. One ischium collected during summer of 1966 is 125 cm long, and the length of the neural spine on the proximal caudal vertebra is 60 cm. Because the hemal arches are about the same dimension, the laterally compressed tail was slightly more than 150 cm wide at its proximal end.

Carnivorous dinosaurs as well as hadrosaurians are represented in the El Gallo Formation by numerous teeth and several vertebral elements. The teeth are the typical compressed, doubly serrate kind that resemble the common late Cretaceous predator *Gorgosaurus*. A single dermal ossicle indicates the presence of ankylosaurs.

Near the coast the major beds containing dinosaur bones consist of brown to black lignitic shales and siltstones intercalated between massive, cross-bedded arkosic arenites. Conglomeratic lenses are common. The abundance of petrified wood is a distinctive characteristic of the arenites. Logs 3.6 to 5 meters long are not uncommon. Bones found in the arenites are generally disarticulated, and most show evidence of abrasion. In general, the more articulated hadrosaurian material is found in the shales and siltstones underlying the coarser arenites. Eastward, but still in the Arroyo Del Rosario, the El Gallo Formation becomes predominantly coarse sandstone and conglomerate, and fossils are much rarer. The upper part of the formation near the unconformity separating it from the Rosario Formation contains a few isolated carbonate lenses rich in marine invertebrates. Occasionally, ammonite fragments are found in the lower shales and arenites. These were either reworked from older units or were washed in from nearby marine areas.

The geography during the time of deposition of the El Gallo Formation was very similar to that of the present, and the Cretaceous strand line was probably not far from the modern one. The lithology of the El Gallo Formation is indicative of near-shore lagoons and playas, a normal habitat for hadrosaurian dinosaurs. Vegetation was much more profuse than that which exists today, and the better-drained areas were thickly wooded. Streams entering the topographic lows deposited coarse fluviatile sediments over the finer materials of the lagoons and playas. The influence of fluviatile processes over marginal marine was more pronounced eastward toward the interior of Baja California where a region of higher relief persisted.

Prior to the discovery of the hadrosaurian *Hypacrosaurus* in Baja California, the genus was known only from the Edmonton Formation of central Alberta, Canada, and one possible specimen from the Two Medicine Formation of Montana. Fossils of *Hypacrosaurus*, usually consisting of disarticulated limb bones or portions of the vertebral column, are common in Alberta and Baja California. The problem of the dispersal route of the genus *Hypacrosaurus* and the question of the temporal equivalence of the two widely separated beds containing dinosaur bones are only partially solved by information from the formations in Baja California.

The Edmonton Formation is generally considered to be stratigraphically younger than the underlying marine Bearpaw Formation although the two apparently interfinger; the Edmonton Formation represents a marginal marine and nonmarine deposit formed during the retreat of the Bearpaw Sea. The Bearpaw Formation, in turn, overlies a second nonmarine unit, the Oldman Formation (*7*). The typical hadrosaurian of the Oldman Formation is the crested form *Corythosaurus*. *Hypacrosaurus* has only been found in the Edmonton Formation.

Potassium-argon (K-Ar) dating has been used to set the time of the retreat of the Bearpaw Sea at 66 to 68 million years ago (*8*). The advance of the Bearpaw Sea, as indicated by K-Ar dates, occurred between 72 and 73 million years ago. The former group of dates gives a maximum age for the Edmonton Formation, while the latter gives a minimum age for the Oldman Formation. Invertebrate faunas from the Bearpaw Formation are indicative of latest Campanian age. With this as a basis, the Edmonton Formation is considered to be Maastrictian, and the Oldman Formation is thought to be Campanian. The K-Ar dates also suggest this chronological sequence (Fig. 1).

The age for the El Gallo Formation (late Campanian) is temporally equivalent to the Oldman or Bearpaw Formation. It has been suggested that *Corythosaurus* is the ancestral form leading to *Hypacrosaurus*, but it may have occurred too late to be the direct ancestor. It is certain that there was some interchange of fauna between Alberta and Baja California during the Cretaceous period. *Hypacrosaurus* from Baja California has been positively identified, and it is a well-established taxon in the Canadian Cretaceous deposits. Possible pathways for distribution of this form were apparently along the tectonic belt (north to south) of the Rocky Mountains. *Hypacrosaurus* has not been found in late Cretaceous deposits along the eastern flank of the Rocky Mountains, although hadrosaurian dinosaurs are common. Hence, *Hypacrosaurus* probably moved into the Baja California area along the Pacific. It is surprising that *Hypacrosaurus* is absent from late Cretaceous beds containing dinosaur bones in northern Mexico and the southern Rocky Mountains. Certainly the presence of this dinosaur in Canada and in Baja California indicates a pandemic population. In spite of this, the mainland faunas seem to have been dominated by various saurolophine hadrosaurs and the genus *Kritosaurus*. The restriction of *Hypacrosaurus* to the Pacific margin of Baja California suggests either a paleoecological or a paleogeographic barrier to the east during late Campanian time.

Ceratopsian dinosaurs have not yet been found in the deposits of Baja California; yet these dinosaurs are very common in late Cretaceous strata along the east flank of the Rockies, and are even present in the deposits of Central America. Absence of this otherwise pandemic form gives further support to the theory of the isolation of the Baja peninsula during the late Cretaceous period. Further paleontologic study of the nonmarine Cretaceous of Baja California will certainly solve some of the problems within this critical area.

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Pleistocene Shoreline Sediments in Coastal Georgia: Deposition and Modification

Abstract. *New evidence invalidates the former concept that Pleistocene shorelines are "terrace" cut and fill structures. Comparison of Pleistocene and Holocene sediments with morphology of the shoreline indicates that Pleistocene deposits accumulated in barrier-island environments and that the "terraces" are former lagoon–salt marshes. Stratigraphic evidence supports six major Pleistocene shorelines below an elevation of 100 feet (30 meters).*

The controversy of a marine versus a fluvial origin for the coastal "terraces" of southeastern Georgia has been summarized by Flint (*1*) and Cooke (*2*). In recent reports, MacNeil (*3*) and Doering (*4*) consider the "terraces" below an elevation of 100 feet (30 m) as marine, but they do not detail the depositional environments; the origin, history, and position of the shorelines is uncertain. This report, based on new sedimentologic and morphologic evidence, outlines briefly the development of the Georgia coastal plain. Similar studies have been completed in southeastern Virginia by Oaks and Coch (*5*); the findings are compared with those we obtained in the study of the Georgia shorelines.

Six major Pleistocene shorelines, at 95 to 100 feet (Wicomico), 70 to 75 feet (Penholoway), 40 to 45 feet (Talbot), 24 feet (Pamlico), 13 feet (Princess Anne), and 4.5 feet (Silver Bluff), occur in Georgia and extend from the present shoreline to an elevation of 100 feet. Deposits of each of these shorelines constitute formations of the same names. Established nomenclature is retained because it is convenient, is widely recognized, and has a useful history of several decades. A change in concept of origin and history of some units is involved, but these changes do not justify major reclassification. Formations are subdivided into barrier-island facies and lagoonal-marsh facies (Fig. 1). Elevations of the lower three shorelines are known with considerably more precision than those of the upper three because of better control from the fossil burrows of the marine decapod *Callianassa* (*Ophiomorpha nodosa* Lundgren). Studies along the Georgia coast show that the upper limit of these burrows can be an indication of