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Cover: Compound faceted spurs along the Wasatch Mountains indicate alternating periods of fault displacement and tectonic stability.
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LATE CENOZOIC MOVEMENT ON THE CENTRAL WASATCH FAULT, UTAH ................................................................. 99

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Remains of Ornithopod Dinosaurs from the Lower Cretaceous of North America

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ABSTRACT—Two new species of ornithopod dinosaurs (Reptilia: Ornithischia) described from the Lower Cretaceous of the western interior of the United States are referred to European genera (Hypsilophodon, Iguanodon). Camptosaurus depressus may be a valid taxon on the basis of a dentary tooth referred to this species. The geographic range of Tenontosaurus is tentatively extended to Arizona and Maryland. A femur from Utah is probably hadrosauroid and represents the earliest record of this family to date. The transatlantic distribution of Hypsilophodon and Iguanodon indicates that there was a land connection between Europe and North America at the beginning of the Cretaceous.

INTRODUCTION

The purpose of this paper is to describe several specimens of herbivorous ornithopod dinosaurs of Lower Cretaceous age from the western interior of North America (Utah, Colorado, South Dakota, and Nebraska) and a tooth from Maryland. Two specimens are particularly important because they represent new species of Hypsilophodon and Iguanodon, two characteristically European species.

Previous Work

Remains of terrestrial vertebrates are extremely rare from the Lower Cretaceous of North America (see survey in Ostrom 1970, p. 124; Langston 1974), with only a few taxa of bipedal ornithopod dinosaurs described to date. A partial skeleton from the Lakota Sandstone (Neocomian) of Calico Canyon, near Buffalo Gap, western South Dakota, was described by Gilmore (1909) as Camptosaurus depressus. Many skeletons from the somewhat earlier Cloverly Formation (upper Aptian-Lower Albian) of Wyoming and Montana have been described as Tenontosaurus tilletti by Ostrom (1970). Langston (1974) describes material of Tenontosaurus sp. from the Comanchean Series of Texas and Oklahoma plus a small hypsilophodontid tooth from Texas. A femur from the Aptian-Albian of Arizona that was described as a camposaur by Miller (1964) is probably also referable to Tenontosaurus (see p. 00). Galton and Jensen (1975) give a preliminary description of American specimens referred to two European genera—a femur of Hypsilophodon (Lakota Sandstone, South Dakota) and maxillary teeth of Iguanodon (Cedar Mountain Formation, Utah). Galton and Jensen (1975) also refer to Iguanodon the distal end of a femur from the Dakota Sandstone of Nebraska which Barbour (1932) considered hadrosauroid.

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SYSTEMATIC PALEONTOLOGY

Order ORNITHISCHIA
Suborder ORNITHOPODA
Family Hypsilophodontidae

Hypsilophodon Huxley 1869
Type species—Hypsilophodon foxii Huxley 1869
Type locality—Isle of Wight, England
Known distribution—Restricted to Wealden Marls (Berriasian) of Isle of Wight (Galton 1974, 1975).

Hypsilophodon weilandi, new species
Etymology—Hypsilophodon weilandi, named for Prof. G. R. Wie- land, who worked the Black Hills of South Dakota so extensively and who collected this specimen in 1900.
Type specimen—AMNH 2589, a left femur (figs. 1A–1F).
Type locality—4.8 km north of Piedmont, western South Dakota.
Horizon—38 m above Morrison beds in Lakota Sandstone (Lower Cretaceous, Aptian-upper Albian).
Diagnosis—The femur of Hypsilophodon weilandi is characterized by a couple of minor differences from that of H. foxii: the ratio of the minimum distance between the proximal end of the femur and the distal edge of the fourth trochanter is 0.45 (0.43 in H. foxii), and distally there is a slight anterior intercondylar groove. For the principal measurements of the femur see table 1.
Comparisons—As in femora of Hypsilophodon foxii (Galton 1969, 1974, 1975), there is a small cleft separating the lesser and greater trochanters (figs. 1C, 1L), an S-shaped ridge on the lateral surface of the greater trochanter (figs. 1A, 1G), and posterodistally the lateral and medial condyles are subequal in size (figs. 1F, 1L). The other hypsilophodontid femora described from North America differ from that of Hypsilophodon weilandi in several respects. In the femora of Othnielosaurus (Galton 1977, described as Nanosaurus (? rex) by Galton and Jensen 1973)
FIGURE 1.—Left femur of Hypsilophodon: A-F, Hypsilophodon veinandi, n. sp., holotype AMNH 2585, X0.33; distal end crushed, but outlines as restored are probably correct; G-L, Hypsilophodon fuscus, BMNH R3560, X0.75. A, G, lateral view; B, H, posterior view; C, I, medial view; D, J, anterior view; E, K, proximal end; F, L, distal end. Muscles after Galton (1909, 1973). The more robust appearance of AMNH 2585 is a function of its much larger size in comparison to BMNH R3580; different sized femurs of Dromsaurs alius show a comparable difference in proportion. CB, M. caudi-femoralis brevis; CL, M. caudi-femoralis longus; f, fourth trochanter; g, greater trochanter; IF, M. ilioc-femoralis; IT, M. iliostopchantes; l, lesser trochanter; m, medial condyle; PI, dorsal part of M. puboischiofemoralis internus; T, tendon inserting on fibula.
Dryosaurus (Galton 1973, 1977) from the Upper Jurassic, there is a deep cleft separating the lesser and greater trochanters whereas in Parkosaurus from the Upper Cretaceous no such cleft is present (Parks 1926). In Othnielina there is no anterodorsal intercondylar groove, but in *Dryosaurus* it is well developed, and posteriorly the lateral condyle is thinner than as is also the case in *Parkosaurus*.

Langston (1974, pl. 2, fig. 3) and Thurmond (1974, fig. 14) refer two small teeth from the Comanchean Series of Texas to the Hysilophodontidae, but they are completely unlike the teeth of any member of this family. The crown is very simple with very faint vertical ridges, and there is practically no cingulum. These teeth may be those of a fabrosaurid ornithopod.

**Family Camptosauridae**

*Camptosaurus* Marsh 1885

*Camptosaurus* (= *Camptonotus*) dispar (March, 1879).

Type locality.—Quarry 13, 13 km east of Como, Albany County, Wyoming.


*Camptosaurus dispar* Gilmore 1909

Type specimen.—USNM 4753, ilia, pubis, and vertebrae.

Type locality and horizon.—Lakota Sandstone from Calico Canyon near Buffalo Gap, Custer County, South Dakota.

*Camptosaurus dispar* Gilmore 1909

Type specimen.—USGS D262, partial crown of a right dentary tooth (figs. 2E-2G) collected by Mr. D. E. Wolcott in 1957.

Horizon and Locality.—Lakota Sandstone 1 m above base, NW 1/4 NW 1/4 sec. 15, T. 7 S, R. 6 E, Hot springs Quadrangle, Fall River Co., South Dakota.

Comparisons.—The thickly enamelled and ornamented surface of the crown (fig. 2E) is notable for the sparsity of vertical ridging with only one long ridge plus two others, neither of which extends further than the middle of the crown. The tubercles of the anterior and posterior edges are not extended into vertical ridges as are some of those on the teeth of *Camptosaurus* (Gilmore 1909) and *Tenontosaurus* (Ostrom 1970). The single long ridge is larger than the others, but it is small in comparison with the prominent keel present on maxillary teeth of *Camptosaurus* (Gilmore 1909; Ostrom 1970, pl. 15G) and on dentary teeth of *Tenontosaurus* (Ostrom 1970, Langston 1974). At midcrown level the thickly enamelled medial surface of the dentary teeth of *Camptosaurus* have from two to four vertical ridges (Gilmore 1909, fig. 2). These teeth also differ from USGS D262 (figs. 2E-2G) in having several tubercules along the tip of the unworn tooth. This is also true for unworn maxillary teeth of *Tenontosaurus* (YPM 5456) in which there are up to nine ridges near the tip of the lateral surface and still four or five ridges halfway down the crown (Ostrom 1970, pl. 10G, D); Langston 1974). A short ridge is present on the thinly enamelled surface of USGS D262 opposite the long ridge of the other side (figs. 2F, 2G). In the teeth of *Camptosaurus* there are several comparable ridges, but none are present in *Tenontosaurus* (YPM 5456).

USGS D262 is similar to the dentary teeth of *Camptosaurus*, and, as the holotype of *C. depressus* is from the Lakota Sandstone of South Dakota, this crown (figs. 2E-2G) is tentatively identified as a right dentary tooth of *C. depressus*. If correctly referred, this tooth supports the contention of Ostrom (1970) that *C. depressus* is a valid taxon.

Associated fauna.—The femur of *Hysilophodon varians* and the partial skeleton (Gilmore 1914, p. 114-21) of the ankylosaur *Hypsilophosaurus marshii* (Lucas 1901) are the only dinosaurs reported to date from the Lakota Sandstone. The latter was discovered alongside the holotype of *Camptosaurus depressus*.

**Family Iguanodontidae**

*Iguanodon* Mantell 1825

Type species.—*Iguanodon mantelli* Meyer 1832.

Type locality.—Near Brighton, Sussex, England.

Known distribution.—Neocomian (Lower Cretaceous) of western Europe, Tunisia, and eastern Mongolia (see below, p. 10).

*Iguanodon osteigeri*, new species

Etymology.—*Iguanodon osteigeri*, named for Mr. Lin Ottinger who collected the holotype in 1968.

Type specimen.—BYU 2000, posterior part of right maxilla with teeth (figs. 2A-2D, 3A).

Type locality.—North of Arches National Park boundary 3.22 km, 1.2 km east of Dalton Well south of U.S. 160 in section 22, T. 24 S, R. 20 E, Grand County, southeastern Utah.

Occurrence.—Specimen was recovered from a thinly bedded deposit of reworked dinosaur bones in the J. Basil Cedar Mountain Formation (Body 1969, Stokes 1952). Other materials collected from the deposit includes scutes and other bones of an ankylosaur. At first sight the fossiliferous zone appears to occur within the upper member of the Morrison Formation (Brushy Basin Member), but *Iguanodon* and ankylosaurs are both characteristic Cretaceous vertebrates. The Cedar Mountain sediments interfinger with the early Mancos Shale sediments in this area and, in some cases, fine Mancos-like but tinted sediments lie directly upon the lower or Salt Wash Member of the Morrison Formation without any intervening resistant sand channels, conglomerates, or hard shales or other sediments characteristic of the Dakota Sandstone, the Cedar Mountain Formation, or the Brushy Basin Member of the Morrison Formation. Because of these local complications in the stratigraphy, the vertebrate remains are used to date the horizon for BYU 2000 which is tentatively regarded as Lower Cretaceous (Neocomian).

Diagnosis.—*Iguanodon*-like teeth with prominent vertical depressions on the anterior and posterior edges of the root and the base of the crown.

Description and comparisons.—Two replacement teeth identify the medial side of BYU 2000 (fig. 2B), so the thickly enamelled and strongly ornamented surface of the crown of the

<table>
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<th>TABLE I</th>
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<tr>
<td>Measures (in mm) of <em>Hysilophodon</em> Femora</td>
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<td>BMNH R5829</td>
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<tr>
<td>AMNH 2585</td>
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F, minimum distance from proximal end to distal edge of fourth trochanter; L, maximum length; Mw, minimum width of shaft; TL, estimated total length (in m) of body based on size of BMNH R196; Wd, maximum width of distal end; Wp, maximum width of proximal end; *, eroding.
functional teeth is the lateral surface (figs. 2A, 3A) and, as a result, BYU 2000 is part of the maxilla. The slope of the dorsal surface is natural (figs. 2A, 2B, 3A), and as the prominent keel (figs. 2A, 3A) is posterior to the median line in ornithopod teeth (Hulke 1885, Gilmore 1909), BYU 2000 is part of the posterior end of the right maxilla. The morphology of the lateral surface of the crown (figs. 2A, 3A) is very similar to this region of an isolated maxilla (BMNH R754) of Iguanodon described by Hulke (1886).

On the posterolateral edge of the crown of the complete tooth there are at least nine well-developed tubercules, each of which continues as a short ridge (figs. 2A, 3A). Along the obliquely inclined ventral edge of the crown there are five small tubercules, the most anterior (i.e., furthest from the prominent keel) of which extends as a short ridge, and then four tubercules that extend as ridges which traverse the height of the crown (figs. 2A, 3A). Along the anterolateral edge (figs. 2A, 3A) there are twelve tubercules of which three extend onto the crown as ridges. The lower part of the medial surfaces of the crowns (fig. 2B) is covered with a thin layer of enamel.

The prominent keel on the lateral surface (figs. 2A, 3A) readily separates the teeth from those of Tenontosaurus, in which such a keel is present only on the dentary teeth (Ostrom 1970, Langston 1974). The complete crown of BYU 2000 differs from those of the maxillary teeth of Compsognathus (Gilmore 1909; Ostrom 1970, pl. 15G) in its larger size, more angular outline (figs. 2A, 3A), and much more prominent keel. In addition, the broken and well-erupted tooth (figs. 2A–2D) shows that there is a deep vertical depression on both the anterior and the posterior edges of the root and base of the crown which receives the upper part of the crowns of the adjacent teeth. No comparable depressions are present on the teeth of Compsognathus, in which each crown slightly overlaps the one behind it (Gilmore 1909, fig. 7).

There is a lot of variation in the form of the maxillary teeth of Iguanodon (e.g., Mantell 1825, 1848; Owen 1855, 1861; Hulke 1886), but those of BYU 2000 are similar to those of BMNH 40100 (figs. 2A–2D; 3A, 3C, 3D) and almost identical to the posterior tooth of BMNH R754 (fig. 3B). In Iguanodon each tooth usually overlaps the one posterior to it (Hulke 1886), but sometimes the anterior edge of the crown and root has a vertical depression to receive the crown of the more anterior tooth (figs. 3C, 3D). However, no tooth of Iguanodon seen by the senior author in the collection of the British Museum (Natural History) has a deep depression on both the anterior and the posterior edges as in BYU 2000 (figs. 2A–2D). An unusual example of tooth replacement for Iguanodon is shown (fig. 3D) where the root of the functional tooth extends dorsally lateral to the replacement tooth (fig. 3C), but medially it does not (fig. 3D). Instead, the replacement tooth fits into a recess at the base of the crown so that it is immediately above the functional tooth but, unlike the situation in hadrosaurs
(Lull and Wright 1942), adjacent tooth series do not show the same feature, and the teeth are not closely packed to form a dental battery.

**Tenuisauras Ostrom**

**Tenuisauras Ostrom 1970**

Type species.—Tenuisauras tilleti Ostrom 1970

Type locality.—AMNH 33-1, SW 1/4 section 26, T. 7 N, R. 16 E, Wheatland County, Montana.

Known distribution.—Cloverly Formation (Aptian-Albian) of Montana and Wyoming (Ostrom 1970); Comanchean Series (Neocomian-Albian) of Texas and Oklahoma (Langston 1974).

**Tenuisauras sp.**

Referred Specimens.—UA 22, nearly complete right femur (fig. 4O); UA 23, two fragments of left femur, described by Miller (1964, pl. 61, figs. A,B; pl. 62, Fig. E).

Locality.—South of Empire Mountains, about 64 km southeast of Tucson, southern Arizona.

Horizon.—Nonmarine facies of Aptian-Albian age.

Comparisons.—The femur is 700 mm long so it is from an animal with a total body length of about 5.2 m. The femur is bowed in medial view (fig. 4O) rather than straight as in hadrosaurids (fig. 4G; Parks 1920, Lull and Wright 1942). Miller (1964, p. 380) noted that this “femur resembles Iguanodon alberfieldei,” however, it differs from members of that genus in that the head is not at right angles to the shaft, the width of the femur is too great, and the shaft is concave distally on the posterior surface.” Although not cleared of matrix, the antero-distal intercondylar groove appears to be not nearly so well developed as in Iguanodon and more comparable to the femora of Camptosaurus. However, the lesser trochanter of UA 20 is not markedly expanded anteroposteriorly as in the femora of Camptosaurus (Gilmore 1909, Galton 1973). In Tenuisauras the lesser trochanter is not expanded (Ostrom 1970), and the form of the rest of the femur is similar to UA 22 (fig. 4P). The more massive construction of the bone and the lower position of the fourth trochanter of UA 20 may be attributed to the difference in size: the femur of Tenuisauras figured is 480 mm (Ostrom 1970, longest femur listed, 580 mm). The femur UA 20 is tentatively regarded as a large femur of Tenuisauras, and its age (Aptian-Albian) is certainly correct. However, it may represent an as yet undefined genus.

**? Tenuisauras sp.**

Referred Specimen.—USNM 244564, incomplete crown of a right dentary tooth (Text-figs. 2H, 2I).

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**Figure 2.** Iguanodonid teeth and a femur; A–D, posterior part of right maxilla with teeth of *Iguanodon altieri* n. sp., holotype BYU 2000 approximately X1. Note that A and B illustrated upside down, A, lateral view, compare with figure 4A; B, medial view; C, ventral view with lateral surface lowermost; D, ventromedial view looking along teeth. E–G, right dentary tooth referred to *Camptosaurus depressus*, USGS D262, X3, E, medial view; F, lateral view; G, dorsal view with medial surface lowermost. H, I, right dentary tooth, ?*Tenuisauras*; USNM 244564, X5, in H, medial view; I, antracondral view; J–N, distal end of left femur; USNM 1200, X0.15, ? hadrosaurian (see also figures 4I–4N), J, lateral view; K, medial view; L, posterior view; M, proximal view; N, lateral view of shaft section to show medial condyles. Broken surfaces shown by cross hatching. Scale lines represent 1 cm in A–I, 10 cm in J–N. 1–5, teeth numbered in order of age: 1, oldest tooth with most of crown broken; 2, functional tooth with obliquely inclined occlusal surface; 3, unworn functional tooth; 4, replacement tooth for 1; 5, replacement tooth for 2.
Horizon and Locality.—Arundel Formation (Neocomian) at the Jessop Police Barracks, Laurel, Maryland.

Comparisons.—The extreme degree of development of the central ridge (fig. 2H, 2I) is matched only among ornithopod taxa described to date by the dentary teeth of Tenontosaurus (Langston 1974, pl. 2, fig. 4; Ostrom 1970, pl. 17, fig. 17). However, USNM 244564 differs from the teeth of Tenontosaurus in two respects. Firstly, it lacks a secondary vertical ridge on the lower half of the crown either side of the central ridge (fig. 2H). Secondly, the central ridge does not extend to the base of the crown so there is a vertically concave area at the base (figs. 2H, 2I). In Tenontosaurus, the central ridge extends to the base of the crown (Ostrom 1970, Langston 1974).

Discussion.—Lull (1911) described the ornithopod Dryosaurus grandis from the Arundel Formation, but Gilmore (1921) showed that the holotype represented a theropod dinosaur, Ornithomimus affinis. Consequently, the dentary tooth (fig. 2H, 2I) is the first evidence for an ornithopod dinosaur from the Arundel Formation, the fauna of which is also discussed by Vokes (1949), Ostrom (1970), and Langston (1974).

Family Hadrosauridae
Hadrosaurinae
BYU 2000.—Badly damaged right femur (figs. 4A–4D).
Locality.—East of Canyonlands Airport 3.22 km, section 28 in T. 23 S, R. 20 E, Grand County, southeastern Utah.

Occurrence.—In the uppermost sediments of the Lower Cretaceous Cedar Mountain Formation in a region of fluctuating early Cretaceous shorelines which generated an interfingeri
of the Lower Mancos Formation shales with the siltstones and sands of the Cedar Mountain Formation.

Description.—The right femur (figs. 2J–2N, 4A–4D) is represented by the globular head and the inner condyle, but most of the shaft is badly eroded. The two sections of the femur measure a total length of 1070 mm with probably about 50 to 100 mm missing so this femur is from an animal with a body length of at least 9 m. Distally the anterior intercondylar groove (figs. 4C–4D) is very deep with a maximum depth of about 65 mm, and it is partly covered by a prominent lateral lip from the inner condyle (fig. 4D) as in hadrosaurs (fig. 4H, Parks 1920, Lull and Wright 1942). The shaft also appears to have been fairly straight in medial view (fig. 4B) with a slight anterior bow in the distal third as is also the case in hadrosaurs (figs. 4B, 4G), and posteriorly the medial condyle is large and upwardly hooked (fig. 4B). However, the anterior intercondylar groove is also very deep in Iguanodon (fig. 4E), and the shaft may be almost straight (fig. 4E). Anteriorly the distal condyles appear to be more pronounced in BYU 2001 (fig. 4B) than in Iguanodon (fig. 4E).

UNSM 1200 (=6-8-28).—Distal and end of left femur (figs. 2J–2N, 4I–4N) described by Barbour (1932).

Locality.—Collected by J. B. White in 1928 on his farm 3.22 km south of Decatur, northeastern Burt County, near the Missouri River, eastern Nebraska.

Horizon.—Dakota Sandstone, Lower Cretaceous, Aptian-Albian (Cobban and Reeside 1952); the correctness of the conclusion by Barbour (1931) that this femur was found in place rather than after transportation is shown by the fact that the consolidated matrix in the anterior intercondylar groove is typical Dakota Sandstone.

Comparisons.—The anterior intercondylar groove is deep (figs. 2M, 2N, 4M, 4O) with a maximum depth of 80 mm. The complete femur was very large for an ornithopod because the anterior-posterior diameter of the inner condyle is 356 mm as against 292 mm for a femur of the hadrosaur Kritosaurus with a length of 1045 mm and from an animal with a total length of about 8.2 m (Parks 1920). Consequently, this distal end is from an animal with a total body length of about 9.7 m. UNSM 200 (figs. 2J–2N, 4I–4N) is similar to the distal ends of the femora of hadrosaurs (figs. 4G, 4H; Parks 1920, Lull and Wright 1942), and it was referred to the hadrosaur Trachodon by Barbour (1931). However, it is also similar to the distal ends of the femora of Iguanodon (figs. 4E, 4F) so this femur is identified as hadrosaurian with less certainty than BYU 2000.

Discussion

The femur (fig. 4A–4D) is definitely hadrosaurian, and that described by Barbour (1931) (figs. 2J–2N; 4I–4N) may also be hadrosaurian. The problem of distinguishing the femora of Iguanodon from those of hadrosaurs is not helped by the fact that, as shown by Rozhdestvensky (1967) and Taquet (1975), hadrosaurs probably originated from Iguanodon-like iguanodontids. The oldest hadrosaur described from North America is from the Eutaw Formation (Upper Cretaceous, Santonian; see Kaye and Russell 1973) of Mississippi. Older Hadrosaurian remains are known from the Upper Cretaceous of England (Cenomanian, Lydekker 1888); Kazakhstan (Cenomanian, Rozhdestvensky 1968); and the eastern Gobi Desert, Mongolia (? Albian, Gilmore 1933, Rozhdestvensky 1967). If correctly identified, the femur (figs. 4A–4D) represents the first remains of a hadrosaur of Lower Cretaceous age and opens up the possibility that more complete remains of a hadrosaur will be exca-
ern hemisphere (Asia America, Asia plus western North America; Euramerica, Europe plus eastern North America) as occurs in the Upper Cretaceous (Cox 1974).

REFERENCES CITED


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**Figure 4.** Iguanodontid and hadrosaurian femora: A-D, hadrosaurid, BYU 2001, right femur: A, anterior view; B, medial view; C, lateral view of distal end; D, distal view; E-F, Iguanodon ateriifrons, Lower Cretaceous of England, right femur BMNH 3364 (from figures supplied by Mr. David Norman): E, medial view; F, distal view; G-H, Hadrosaurid from New Jersey, right femur, after Leidy (1865, pl. 15); G, medial view; H, distal view; I-N, hadrosaurid (or ? iguanodontid), distal end of left femur USNM 1200: I, lateral view; J, posterior view; K, medial view; L, anterior view; M, section in medial view; N, distal view; O, *Iguanodon* sp., UA 21 right femur in medial view, P. *Iguanodon* sp., left femur in medial view, after Ostrom (1970, pl. 20). Scale lines represent 10 cm, broken bone shown by mechanical shading. a, anterior intercondylar groove; f, fourth trochanter; i, lateral condyle; j, medial condyle.
Miller, H. W., Jr., 1964, Ceratopsian dinosaur remains from southern Arizona: Jour. Paleont., v. 38, p. 378-84.


FIGURE 5.—Map to show localities and the distribution of land in part of the northern hemisphere during the Lower Cretaceous, after Galton and Jensen (1975) and modified from Cox (1974) --- reconstructed coastline; --- present coastline; --- extent of North Atlantic after Diets and Holden (1970); --- circulation currents, after Berggren and Hollister (1974); cross hatching, epicontinental sea, after Hallam (1971); H, H. R. Elles reconstructions of Hypsilophodon and Iguanodon with body lengths of up to 2.3 meters and 9 meters, respectively; A, Hypsilophodon localities; I, Iguanodon localities; T, Tenontosaurus locality; 1, southern Arizona; 2, southern Utah; 3, western South Dakota; 4, eastern Nebraska; 5, southern England; 6, Belgium; 7, France; 8, Spain; 9, Portugal; 10, Tunisia; 11, Spitzbergen; 12, eastern Gobi Desert (symbol shifted slightly left).