

# A HISTORICAL AND BIOGEOGRAPHICAL EXAMINATION OF HADROSAURIAN DINOSAURS

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**Abstract**—Duck-billed dinosaurs, or hadrosaurs, rank among the most unique, specialized, and successful dinosaur groups. They are known from localities throughout the Northern Hemisphere, predominately in North America and Asia, as well as from South America and Antarctica. During their Cretaceous tenure, hadrosaurs diversified into an array of crested and non-crested forms. This paper reviews the history of hadrosaur discoveries, placing them into geographic context, noting 27 valid taxa from North America, 16 from Asia, two from South America, two from Europe, and one occurrence from Antarctica.

## INTRODUCTION

Hadrosaurs are among the most diverse and successful dinosaur groups. Their fossil record is concentrated in a 15 million year period in the latest Cretaceous (Campanian-Maastrichtian), about 10 million years after their putative Cenomanian origin (Weishampel and Horner, 1990; Head, 1998). They were the last major clade of ornithomimid dinosaurs to evolve during the Mesozoic (Horner et al., 2004), and have been found on five of the seven continents, with the predominance of fossil remains coming from North America and Asia (Weishampel and Horner, 1990; Horner et al., 2004). Their remains are often prolific—ranging from complete articulated skeletons to disarticulated and isolated elements—suggesting that, in many instances, they were the dominant herbivores in their ecosystems. Supplementing the vast skeletal sample of adult materials are the remains of eggs, embryos, hatchlings (perinates), and juveniles, as well as tracks and trackways, skin impressions, and even coprolites (Horner et al., 2004).

Two main groups or clades of hadrosaurs are recognized: Hadrosaurinae, the non-crested forms, and Lambeosaurinae, the hollow-crested forms. Lambeosaurines are distinguished by the presence of a hollow supra-cranial crest containing the nasal tubes. Hadrosaurines, on the other hand, lack a hollow crest, although some representatives possess solid supra-cranial ornamentation.

Research on what was to become ornithomimids began in 1822, with the discovery of bizarre looking teeth from the West Sussex area of England by Gideon and Mary Ann Mantell. These teeth, later described as *Iguanodon* by Gideon Mantell in 1825, gave the world its first premonitions of past monsters of the Mesozoic (Fastovsky and Weishampel, 2005). Nearly a quarter century later, similar research in North America was initiated by Joseph Leidy in 1856, on material from Montana, South Dakota and later in 1858 on considerably better preserved materials (Horner et al., 2004).

From humble beginnings of isolated teeth and vertebrae, hadrosaurs have become some of the most commonly found dinosaurs in Upper Cretaceous deposits. Remains of these animals are now known from every continent except Africa and Australia, and their distribution ranged from pole to pole. It is because of this large distribution and high fossil occurrence that hadrosaurs have become one of the best known groups of dinosaurs.

Here we present a synopsis of the history of hadrosaur discoveries from around the world to highlight how integral these dinosaurs have been to the study of Late Cretaceous ecosystems. This paper is limited to providing a historical context for the discovery and research of these dinosaurs; see Horner et al. (2004) for a substantial discussion of paleobiology and phylogenetic relationships. Much of the historical information written here has come from compiling documented research chronicles in many other publications, and we thank those authors who have provided their readers with this historical context. Abbreviations: AEHM=Amur Natural History Museum, Blagoveschensk, Russia; AMNH=American Museum of Natural History, New York, USA; ANSP=Academy of Natural Sciences of Phila-

delphia, Philadelphia, Pennsylvania, USA; BMNH=The Natural History Museum, [formerly] British Museum of Natural History, London, England; BYU=Brigham-Young University, Provo, Utah, USA; CEUM=College of Eastern Utah Museum, Price, Utah, USA; CUST=Changchun University of Science and Technology, Changchun, P.R. China; FMNH=The Field Museum, [formerly] Field Museum of Natural History, Chicago, Illinois, USA; GSC=Geological Survey of Canada, Ottawa; IVPPAS=Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica, Beijing, China; MLP=Museo de La Plata, Buenos Aires, Argentina; MOR=Museum of the Rockies, Bozeman, Montana, USA; NMC=National Museum of Canada, Ottawa, Canada; NMMNH=New Mexico Museum of Natural History and Science, Albuquerque, New Mexico, USA; PIN=Paleontological Museum, Moscow, Russia; PMU=Museum of Evolution, Uppsala University, Uppsala, Sweden; PU=Princeton University, Princeton, New Jersey, USA; ROM=Royal Ontario Museum, Toronto, Canada; SEPCCP=Secretary of Public Education of Coahuila, Paleontological Collection; SMU=Shuler Museum of Paleontology, Southern Methodist University, Dallas, Texas, USA; UCMP=University of California Museum of Paleontology, Berkeley, California, USA; UHR=University of Hokkaido Registration, Japan; YPM=Yale Peabody Museum, New Haven, Connecticut, USA; ZPAL=Paleobiological Institute of the Polish Academy of Sciences, Warsaw, Poland.

## NORTH AMERICA

North American hadrosaur discoveries began in 1858 with the discovery of fossil bones from the Cretaceous marls of the Woodbury Formation, in Haddonfield, New Jersey (Foulke, 1859; Weishampel and White, 2003; Prieto-Marquez et al., 2006). William Parker Foulke and Joseph Leidy put forth the first description of these fossils, Foulke providing insights into the Late Cretaceous paleoecology of New Jersey, whereas Leidy executed the actual morphologic descriptions and proposed the name *Hadrosaurus foulkii*, in honor of Foulke (Prieto-Marquez et al., 2006). The partial skeleton, ANSP 10005—including teeth, fragmentary jaw, numerous vertebrae, and partial forelimb and hindlimb—was the first dinosaur discovered in the New World and the first dinosaur skeleton mounted for exhibition at the Museum of the Academy of Natural Sciences in Philadelphia (Ruschenberger and Tryon, 1879). *Hadrosaurus* is the type genus of the family Hadrosauridae Cope, 1869 and the subfamily Hadrosaurinae Cope, 1869 (Lambe, 1918; Prieto-Marquez et al., 2006). Prieto-Marquez et al. (2006) declared the genus *Hadrosaurus* a *nomen dubium* because the type specimen lacks unequivocal autapomorphies or any combination of characters that make it differentiated from other hadrosaurid taxa, yet they retained the family and subfamily taxonomy.

In 1871, O. C. Marsh collected a postcranial skeleton and skull fragments from the Smoky Hill Chalk Member of the Niobrara Chalk Formation in western Kansas, later naming this specimen, YPM 1190, *Hadrosaurus agilis* (Marsh, 1872). Subsequent discoveries of hadrosaurid material led Marsh to conclude that *Hadrosaurus agilis* actually represented a new genus and species, *Claosaurus agilis* (Marsh, 1890; Glut,

1997). Marsh described *Claosaurus* as being one-third the size of *Hadrosaurus foulkii*, having more slender proportions, and smaller cervical vertebrae (Marsh, 1890). In their classic monograph of hadrosaurian dinosaurs, Lull and Wright (1942) noted that without substantial skull material, little could be stated regarding the taxonomic status of *Claosaurus*.

During the dinosaur rush of the late 1800's and early 1900's, congeneric material was collected by competing researchers who insisted on naming as many taxa as possible, thereby confusing hadrosaur taxonomy for close to a century. In a classic example, J. B. Hatcher collected two hadrosaur skeletons from the Lance Formation, Niobrara County, Wyoming, in 1891. Marsh (1892) referred them to the new species *Claosaurus annectens*. Later, during the E. D. Cope expedition of 1882 to South Dakota, J. L. Wortman and R. S. Hill collected a complete hadrosaurid skeleton, AMNH 5730, from the Lance Formation north of the Black Hills, South Dakota. Then, in 1904, a second almost complete skeleton of the same species from the Lance Formation of Montana, AMNH 5886, was collected by B. Brown and P. Kaisen, and designated the paratype of *C. annectens*. The two skeletons were displayed at the American Museum of Natural History, the holotype mounted in a quadrupedal posture and the paratype mounted in a bipedal posture. Cope originally referred them to Leidy's *Trachodon mirabilis*, but renamed them *Diclonius mirabilis*, because Cope believed Leidy had completely abandoned the name *Trachodon* (Glut, 1997). Lull and Wright (1942) referred Marsh's *Claosaurus annectens* to the new genus *Anatosaurus annectens*, which they erected to dispel the confusion surrounding the many similar, yet differently named, flat-headed hadrosaurs. They also placed *Diclonius mirabilis* into this genus, erecting a new species, *Anatosaurus copei*. M. K. Brett-Surman (1975, 1979) recognized *A. annectens* as a junior synonym of *Edmontosaurus regalis*, placing it within *Edmontosaurus*. Chapman and Brett-Surman (1990) found *A. copei* to be generically distinct from *Edmontosaurus*, erected the new genus *Anatotitan* (Glut, 1997), and sunk *Anatosaurus*.

Originally, Lambe (1917b) described *Edmontosaurus regalis* based on a complete skull and nearly complete postcranial skeleton, NMC 2288, collected by L. Sternberg in 1912 from the Horseshoe Canyon Formation of Alberta (Glut, 1997). Sternberg (1926) originally described material he collected in 1921 from the Frenchman Formation, Saskatchewan, Canada, as a new species of *Thespesius*. This material was later referred to *Anatosaurus, A. saskatchewanensis*, by Lull and Wright (1942); however, Russell and Chamney (1967) later assigned this enigmatic specimen to *Edmontosaurus saskatchewanensis*. Presently, only three species of *Edmontosaurus* are considered valid, although various other taxa have been referred to this genus and later retracted. The latter include *Trachodon avatus* (Cope, 1871), *Agathaumas milo* (Cope, 1871), *Trachodon selwyni* (Lambe, 1902), *Thespesius edmontoni* (Gilmore, 1924), and *Thespesius saskatchewanensis* (Sternberg, 1926).

Another major taxonomic controversy that is still debated today regards the relationship between the genera *Kritosaurus* and *Gryposaurus*. In 1904, B. Brown collected an incomplete hadrosaur skull, AMNH 5799, from the Kirtland Formation near Ojo Alamo, San Juan County, New Mexico, which he described as *Kritosaurus navajovius* (Brown, 1910). The type specimen lacked the nasals and premaxillae, both key autapomorphic elements, and hence, Hunt and Lucas (1993) regarded *K. navajovius* as a *nomen dubium* (also see Lucas et al. and Kirkland et al., in this volume).

Brigham Young University collected a partial skull, BYU 12950, in 1992 from the Farmington Member of the Kirtland Formation of Kimbeto Arroyo, northwestern New Mexico (Horner 1992). Horner (1992) originally regarded the holotype skull as attributable to *Kritosaurus navajovius*. However, Hunt and Lucas (1993) later described the same skull, erecting a new genus and species *Anasazisaurus horneri*, based upon the specimen's distinct nasal morphology (also see Lucas et al., this volume).

Hunt and Lucas (1993) also created the taxon *Naashoibitosaurus ostromi* for a partial skull, NMMNH P-16106, collected by D. D. Gillette and D. Thomas from the De-na-zin Member of the Kirtland Formation in northwestern New Mexico. Horner (1992) referred the material to

*Kritosaurus navajovius*, but Hunt and Lucas found this placement erroneous, and argued for retaining the new genus and species. Most recently, Horner et al. (2004) considered *Naashoibitosaurus* to be more representative of the type and referred all material from *Kritosaurus* to *Naashoibitosaurus*.

The type specimen of *Gryposaurus notabilis* was named from an articulated skull and unprepared postcrania, NMC 2278, from the Dinosaur Park Formation (Lambe, 1914). Parks (1920) named a contemporaneous species, *incurvimanus*, ROM 764, also from the Dinosaur Park Formation. Horner (1992) erected a new species, *Gryposaurus latidens*, on the basis of a nearly complete skeleton with associated skull and tail section, AMNH 5465, collected from the lower Two Medicine Formation, Pondera County, Montana.

Debate over the relationship of these taxa has continued because they both share similar morphology of the mandible and postnasal skull. The anterior portion of the type specimen of *Kritosaurus* has been reconstructed in plaster because of the missing elements. Originally, Brown (1910) had the skull reconstructed with no crest and "typical" premaxillae. Yet, after discovery of *Gryposaurus notabilis* by Lambe (1914), and the apparent similarity between the preserved parts of the skull, Brown had *Kritosaurus* remodeled after *Gryposaurus notabilis*. The generic confusion was evident in 1920 when Parks named *Gryposaurus incurvimanus*, and *Kritosaurus incurvimanus*, stating that even though *K. incurvimanus* was collected from the same beds as *G. notabilis*, the name *Kritosaurus* takes precedence over *Gryposaurus* because of publication dates. However, he also mentioned that if ever the two genera were proven to be distinct, *K. incurvimanus* should be named *Gryposaurus incurvimanus*. Lull and Wright (1942) followed suit with Parks and synonymized all material pertaining to *Gryposaurus* into *Kritosaurus*. Fifty years later, Horner (1992) defended the generic separation by citing morphological differences seen in *Anasazisaurus* and *Naashoibitosaurus* (both possibly referable to *Kritosaurus*, but currently distinct) that differed from *Gryposaurus*.

Yet, probably the most confusion within hadrosaur taxonomy involved creating separate genera and species for each of the growth stages of *Lambeosaurus*, *Hypacrosaurus*, and *Corythosaurus*. In 1913 and 1917, two fragmentary hadrosaurid skulls were collected from the Dinosaur Park Formation of Alberta, Canada (Glut, 1997). Lambe originally thought these skulls were conspecific with *Trachodon marginatus* [*nomen dubium*]; subsequently realizing his mistake, Lambe (1914) referred them to a new genus, *Stephanosaurus*, retaining the original specific name. Parks (1923) later overturned this assignment, erecting a new genus and species for the two skulls, *Lambeosaurus lambei*, after which Gilmore (1924b) designated the better of the two specimens, GSC 2869, as the lectotype. Sternberg (1935) described material he collected in 1919 from the Dinosaur Park Formation (Lethbridge Coal Seam [D. Evans, pers. comm.]), Alberta, Canada, erecting a new species, *L. magnicristatus*, founded upon a skull with nearly complete postcrania. Material collected in 1888 by J. B. Hatcher from the Judith River Formation, Fergus County, Montana, was originally referred by Marsh (1889) to *Hadrosaurus paucidens*, but later changed to *Ceratops paucidens* Marsh (1890). Ostrom (1964), reevaluating this material, proposed that it be referred to *Lambeosaurus* based on close similarities between the two. Ostrom (1964) later argued that the two specimens could not conclusively be shown to be conspecific, and proposed that the material be designated as a new species of *Lambeosaurus*, *L. paucidens*, which Prieto-Marquez et al. (2006) consider an intermediate lambeosaurine. A third species, *?L. laticaudus*, was founded upon fragmentary material collected from the informally named "El Gallo Formation," Baja California Del Norte, Mexico (Morris, 1981). Currently only three species of *Lambeosaurus* are considered valid (Glut, 1997); however, numerous other taxa are considered to be junior synonyms of this genus: *Hadrosaurus paucidens* (Marsh, 1889), *Didanodon altidens* [*nomen nudum*] (Osborn, 1902), *Procheneosaurus* (Matthew, 1920), *Tetragonosaurus praeceps* (Parks, 1931), *Tetragonosaurus erectofrons* (Parks, 1931), *Tetragonosaurus cranibrevis* (Sternberg, 1935), *Corythosaurus frontalis* (Parks, 1935), and *Lambeosaurus clavinitialis* (Sternberg, 1935).

*Hypacrosaurus* was named by Brown (1913) based on postcranial remains collected in 1910 from the Horseshoe Canyon Formation of Alberta by a team from the American Museum of Natural History. Brown (1913) originally diagnosed the type species, *H. altispinus*, based on the height of the dorsal vertebral neural spines, which he found to be five to seven times higher than their respective centra. Gilmore (1924) supplemented Brown's original diagnosis, adding cranial characters from the plesiotype skull. Lambe (1917a) named a new lambeosaurine taxon, *Cheneosaurus tolmanensis*, for a smaller skull and associated postcrania, NMC 2246, collected by G. F. Sternberg in 1915 in deposits of the Horseshoe Canyon Formation, Alberta. Nopcsa (1933) first proposed that *C. tolmanensis* could be a juvenile form of *Hypacrosaurus*. Later, Dodson (1975) demonstrated that *C. tolmanensis* did indeed represent a juvenile form of *H. altispinus*. Horner and Currie (1994) described *Hypacrosaurus stebingeri* from a complete, articulated adult skull, MOR 549, collected from the Two Medicine Formation, Glacier County, Montana. Many specimens have been referred this species, including eggs, nests (some complete), and hundreds of skeletal elements, making it one of the best samples of hadrosaur growth presently known.

Finally, B. Brown (1914) collected a nearly complete hadrosaur skeleton, AMNH 5240, from the Dinosaur Park Formation of Alberta, which he described as *Corythosaurus casuarius*. Today, only this one species of *Corythosaurus* is considered valid; however, various other species have been referred to the genus: *C. excavatus* (Gilmore, 1923), *C. intermedius* (Parks, 1923), *C. bicristatus*, (Parks, 1935), and *C. brevicristatus* (Parks, 1935). Dodson (1975) reduced the species count to one, *C. casuarius*. Additional taxa are now considered junior synonyms of *C. casuarius*: *Pteropelyx* (Cope, 1889), *Procheneosaurus* (Matthew, 1920), *Tetragonosaurus erectofrons* (Parks, 1931), and *Tetragonosaurus cranibrevis* (Sternberg, 1935). Lull and Wright (1942) resurrected *Procheneosaurus*, referring *T. cranibrevis* to *P. altidens*, and *Trachodon altidens* to *P. cranibrevis*, though these taxa are now considered *nomen dubia*.

A wonderful new lambeosaurine specimen was discovered in southern Alberta by L. Sternberg in 1921, and later dubbed *Parasaurolophus walkeri* by Parks (1922). *Parasaurolophus* has become the archetypal lambeosaurine, with its one meter long tube-like crest extending rearward from the nasal region. Wiman (1931) erected a new species of *Parasaurolophus*, *P. tubicen*, founded upon a fragmentary skull from the Fruitland Formation, New Mexico, collected by C. H. Sternberg in 1921. Ostrom (1961a, 1963) later erected another new species of *Parasaurolophus*, *P. cyrtocristatus*, based on a nearly complete skeleton and fragmentary skull, FMNH P27393, also collected in 1923 from the Fruitland Formation of New Mexico. Weishampel and Jensen (1979) described the distal end of a *Parasaurolophus* crest, BYU 2467, regarded as *incertae sedis*, from the Kaiparowits Formation, Garfield County, Utah. A recently recovered specimen from the Kaiparowits Formation, UCMP 143270, demonstrates that the BYU specimen can likely be referred to *P. cyrtocristatus* (Sullivan and Williamson, 1999; Gates, 2004).

C. M. Sternberg (1953) collected a skull with fragmentary postcrania, NMC 8893, from the Oldman Formation of Alberta in 1936, from which he named *Brachylophosaurus canadensis*. Sternberg originally interpreted *B. canadensis* as a new species of *Gryposaurus*, but later found it to be generically distinct (Sternberg, 1953). Horner (1988) erected a second species of *Brachylophosaurus*, *B. goodwini*, based upon a partial skull with incomplete postcrania, UCMP 130139, discovered by Mark Goodwin in 1981 in the Judith River Formation of Montana. Prieto-Marquez (2005) later synonymized *B. goodwini* with *B. canadensis*. Further discoveries in the Judith River Formation include a bonebed of remarkable *Brachylophosaurus* specimens preserved with integument and possible stomach contents (Murphy et al., 2002).

A closely related species, *Maiasaura peeblesorum* (Horner and Makela 1979; Horner, 1983), was discovered in 1978, by Marion Brandvold and her son David Trexler within a huge bone bed, later dubbed Egg Mountain, in the Willow Creek anticline in the Two Medicine Formation of Montana. Horner and Makela (1979) erected the genus upon a virtually complete skull, PU 22405, lacking only the prementary and right dentary. Over

200 specimens are known with various states of preservation, from embryos to adult forms (Glut, 1997). *Maiasaura* was the first hadrosaur found together with putative eggs, nests, and hatchlings, leading to several new hypotheses relating to dinosaur behavior, growth, and intelligence (Horner and Weishampel, 1989).

Brown (1912) described *Saurolophus osborni* from a nearly complete skeleton with skull and integument, AMNH 5220, collected in 1911 by the American Museum of Natural History from the Horseshoe Canyon Formation, Alberta. *Saurolophus* was the first Canadian dinosaur known from a nearly complete skeleton (Glut, 1997).

Meaning "before *Saurolophus*," *Prosaurolophus maximus* (Brown, 1916) is known from a complete skull, AMNH 5836, collected in 1915 by the American Museum of Natural History in the Dinosaur Park Formation of Alberta. The genus is distinguished by a small crest that rises out of the top of the head that is smaller, but resembles that of *Saurolophus*. Horner (1992) erected a new species of *Prosaurolophus*, *P. blackfeetensis*, based on a specimen, MOR 454, collected from the upper Two Medicine Formation, Glacier County, Montana. Specimens referred to this species include portions of numerous skulls and skeletons (e.g., MOR 447, 553; Glut, 1997).

In 1946, R. Zangerl, W. Turnbull, and C. M. Barber collected a mostly complete, partially articulated hadrosaur skeleton, FMNH P27383, from the Mooreville Chalk, Dallas County, Alabama. The partial skull possessed an upturned crest similar to *Prosaurolophus*, yet positioned lower on the nasals, and it possessing a large fontanelle at the nasal-frontal contact. Langston (1960) established this material as *Lophorothon atopus*. It is one of the most complete hadrosaurs to be discovered east of the Western Interior Basin.

Basal hadrosauroid material has also been recognized from North America. In 1993, Carol and Ramal Jones of Salt Lake City, Utah, found fragmentary bone weathering out of the Cedar Mountain Formation, in the northwestern San Rafael Swell east of Castle Dale, Utah. The finding was brought to the attention of D. L. Burge, director of the College of Eastern Utah, Prehistoric Museum in Price, Utah, who, along with his staff, conducted an excavation of the site (Kirkland, 1998). The specimen is that of a partial adult hadrosaur skeleton with an associated, disarticulated skull. Additional material pertaining to this new taxon was simultaneously being excavated by R. Cifelli of the Oklahoma Museum of Natural History, in the southwestern portion of the San Rafael Swell. J. I. Kirkland (1998) established *Eolambia caroljonesa*, on a disarticulated partial adult skeleton, CEUM 9758. Kirkland's original description placed *E. caroljonesa* as a crestless basal lambeosaurine on the basis of cranial and postcranial synapomorphies. More recent analysis of paratypic materials by J. Head (1999) reported none of the previously identified synapomorphies uniting *E. caroljonesa* and Lambeosaurinae. Additionally, the material was found to possess plesiomorphic characters shared with more basal members of Iguanodontia (Head, 1999). This reanalysis resulted in the exclusion of *E. caroljonesa* from any definition of Hadrosauridae, placing it as a *Probactrosarus*-grade iguanodontian (Head, 1999) or hadrosauroid.

Head (1998) described a disarticulated skull with associated fragmentary postcrania, SMU 74582, discovered in 1994 in the Woodbine Formation, Flower Mound, Texas, as the hadrosauroid *Protohadros byrdi*. It remains the most complete pre-Turonian hadrosauroid skull known (Weishampel 1990; Weishampel and Horner 1990).

Hadrosaurid material has been reported as far north as the North Slope and Talkeetna Mountains of Alaska (Gangloff, 1998). These remains have been separated into three taxa: *Edmontosaurus* sp., *Kritosaurus* sp., and an unidentifiable lambeosaurine (Pasch and May, 1997).

#### SOUTHEAST RUSSIA/NORTHEAST CHINA

The first discovery of Asian hadrosaurs did not come from the famed American Museum of Natural History expedition of 1922, but from a Russian army colonel named Manakin, working along the banks of the Amur River in northern China in 1902 (Godefroit et al., 2001). Subsequent expeditions to the area by Russian geologists eventually uncovered a large,

multitaxic bonebed in the Chinese village of Jiayin. The first hadrosaurs to be named from this bonebed were *Mandschurosaurus amurensis* and *Saurolophus kristofovici* (Riabinin, 1930a, b). Today, both of these taxa are unanimously regarded as *nomen dubia* because the described materials are not diagnostic (Brett-Surman, 1979; Maryanska and Osmolska, 1981a; Horner et al., 2004). The Heilongjiang Provincial Museum eventually undertook further excavations and, using material originally described by Yang et al. (1986), Yang (1987), and Xing et al. (1994), Godefroit et al. (2000) finally attributed the material in the Jiayin bonebed to the lambeosaurine hadrosaur *Charonosaurus jiyinensis*.

Other material in the Amur River valley includes the lambeosaurine *Olorotitan*, found at the Kundur locality; this specimen represents the most complete hadrosaur known from Russia (Godefroit et al., 2003). Finally, *Amurosaurus* (Bolotsky and Kurzanov, 1991; Godefroit et al., 2004) was identified from a large bonebed assemblage located at the Blagoveschensk locality. Riabinin (1930a) originally identified hadrosaur remains of *Mandschurosaurus amurensis* from fragmentary material obtained at this locality, but this material was subsequently regarded as undiagnostic (Brett-Surman, 1979; Godefroit et al., 2004).

Fragmentary hadrosaurine specimens belonging to *Kerberosaurus manakini* were found alongside the *Amurosaurus* bones within the Blagoveschensk locality. This close association of hadrosaurine and lambeosaurine taxa provides an interesting glimpse into the paleoecology of this poorly known region. In most instances in North America, the two groups of hadrosaurs are not found together in the same bonebed. The notable exception is the Two Medicine Formation, where harsh climatic conditions apparently forced different taxa into small confined areas to die and become fossilized (Rogers, 1990; Varricchio, 1995). Potentially, the appearance of the hadrosaurines and lambeosaurines in the same bonebed in this region of Asia represents an analogous, climatically-induced deposit.

The Wangshi Group of the Shandong Province, People's Republic of China, has produced three hadrosaurs. The first, *Tanius sinensis*, was described by Wiman in 1929. Later, Young (1958) erected *T. chingkankouensis*, although this taxon was later regarded as invalid (Buffetaut and Tong-Buffetaut, 1993). However, Young (1958) did name *Tsintaosaurus* from specimens found in the same sediments. This taxon has been the subject of much debate; it is considered by some to be a member of Lambeosaurinae because of the presence of a large, straight "crest" composed of nasals and directed dorsally from the skull roof. Other researchers have claimed that this crest is actually a hadrosaurine nasal that has been distorted postmortem from a more standard anatomical position (Taquet, 1991; but see Buffetaut and Tong-Buffetaut, 1993 for support of the original interpretation). The last of the Wangshi hadrosaurs is *Shantungosaurus* (Hu, 1973), the largest hadrosaur known. Remarkably, the femur of the holotype specimen is almost two meters long (Hu, 1973).

#### INNER MONGOLIA

The American Museum of Natural History expedition to Mongolia in 1921 opened up the great paleontological potential of Asia to the western world. Despite the tremendous abundance of dinosaur skeletons—mostly ceratopsians, pachycephalosaurs, and maniraptoran theropods—found in the Flaming Cliffs region of Mongolia (Djadokta Formation), no hadrosaurs have been described from these sediments. However, that first trip did discover many sites within the Iren Dabasu Formation that have yielded numerous hadrosaur skeletons. Walter Granger, Roy Chapman Andrews, and their crew excavated the Johnson Quarry in 1922, found by team member Albert Johnson the year before and located just eight miles to the east of the Iren Dabasu telegraph station (Gilmore, 1933; Colbert, 2000). This quarry yielded many juvenile individuals of the primitive hadrosaur *Bactrosaurus johnsoni* (Gilmore, 1933). Less than a mile to the east, the expedition located a bonebed containing remains of another primitive hadrosaur, originally named *Mandschurosaurus mongoliensis* by Gilmore (1933), and since placed in *Gilmoresaurus mongoliensis* (Brett-Surman, 1979),

#### MONGOLIA

Currently, only two hadrosaurs are known from Mongolia, both from the Nemegt Formation. *Barsboldia* was discovered from the Nemegt locality in 1970 and originally considered *Saurolophus angustirostris* (see below) by Gradzinski and Jerzykiewicz (1972). Maryanska and Osmolska (1981b) identified the skeletal remains of a torso region as *Barsboldia* based on characters of the vertebrae and pelvis. It is considered by some to be a *nomen dubium* (e.g., Norman and Sues, 2000) because it is composed exclusively of postcranial elements. However, the sacral vertebrae are extremely high and possess a club-like apex, a character that differentiates this taxon from all other lambeosaurines.

In May of 1948, the Russian expedition discovered skeletons of *Saurolophus angustirostris* (Rozhdestvensky, 1952; Kurochkin and Barsbold, 2000). Since this discovery, many other *S. angustirostris* bonebeds have been excavated, making it one of the best known Asian hadrosaurs (Norman and Sues, 2000). Rozhdestvensky (1952) erected the new species on the basis of some subtle differences in the skull relative to the North American form *Saurolophus osborni* (Brown, 1913). However, the validity of *S. angustirostris* has been questioned by Norman and Sues (2000), who argued that comparison to *S. osborni* is problematic because the North American species has not been fully described. *Saurolophus* is biogeographically interesting, as it is the only hadrosaur genus known from both North American and Asia.

#### JAPAN/NORTHEAST RUSSIA

Iguanodontid fossils are not common in Japan, but hadrosaurid dinosaurs are even rarer. The only known hadrosaur taxon comes from a partial skeleton collected in a coal mine on the northern island of Sakhalin (previously part of Japan; now under Russian control). *Nipponosaurus*, which translates as "Japanese lizard," was named from a juvenile individual with a poorly preserved skull and partial postcranium. Nagao (1936) placed *Nipponosaurus* within the Lambeosaurinae, and in a recent redescription, Suzuki et al. (2004) reaffirmed Nagao's assessment, placing this taxon as the sister taxon to *Hypacrosaurus altispinus*.

#### KAZAKHSTAN

The Russians undertook exploratory expeditions into the Aral Mountains of Kazakhstan from 1957 to 1962. The largest and most productive area was the Turonian-Santonian aged Shakh-Shakh locality, yielding the three most complete hadrosaur skulls from Kazakhstan: *Aralosaurus tubiferous*, *Procheneosaurus convincens*, and *Jaxartosaurus aralensis* (Rozhdestvensky, 1968). Originally described as a hadrosaurine closely related to *Gryposaurus* (Rozhdestvensky, 1968), *Aralosaurus* is now considered by some to be a primitive member of Lambeosaurinae because of the presence of several synapomorphies; these include a premaxillary ramp on the maxilla and a hollow excavation within the nasals that supposedly housed portions of the nasal cavity (Godefroit, 2004). *Jaxartosaurus*, on the other hand, is clearly a lambeosaurine based on the distinctive morphology of the preserved skull roof. Godefroit et al. (2004) posit this taxon as a basal member of the subfamily, but the specimen provides limited cladistic utility because of its fragmentary nature.

The lambeosaurine *Procheneosaurus convincens* has had a tumultuous taxonomic history because the specimen is that of an immature individual. Dodson (1975) recognized that numerous genera and species of lambeosaurines from the Belly River Group of Alberta were based upon juvenile materials attributable to larger taxa; consequently, he subsumed several of the small-bodied forms into other large-bodied taxa. *Procheneosaurus* thus became a junior synonym of *Corythosaurus*, leaving the species *convincens* without a generic designation. Maryanska and Osmolska (1981a) advocated creating a new genus for the Asian *Procheneosaurus*, although Weishampel and Horner (1990) regarded the

specimen as a juvenile of *Jaxartosaurus*. Norman and Sues (2000) later acknowledged that *Jaxartosaurus* and *P. convincens* are from disparate geographic and stratigraphic locations, raising questions about uniting these taxa. The morphology of *P. convincens* is similar to the North American “corythosaurs” (Rozhdestvensky, 1968). Evans et al. (2005) identified characters that allow taxonomic differentiation between juvenile individuals of three different North American “corythosaurs”: *Corythosaurus*, *Hypacrosaurus*, and *Lambeosaurus*. A redescription of *P. convincens*, utilizing the new taxonomic data on juvenile lambeosaurs, is necessary before further progress can be made on the taxonomic identity of these materials.

### EUROPE

In 1900, hadrosaurian remains were discovered on the estate of the Nopcsa family in Romania. These fossils were described by F. Nopcsa as *Limnosaurus*, but he later renamed them *Telmatosaurus* (Nopcsa, 1903) because the former name was occupied by a crocodile (Weishampel et al., 1993; Fastovsky and Weishampel, 2005). The only other hadrosaurid to be described from Europe is the putative lambeosaur *Pararhabdodon*, from northern Spain (Casanovas et al., 1993). These taxa are interesting because both occur in Maastrichtian sediments, yet both are primitive members within Hadrosauridae. Indeed, *Telmatosaurus* is regarded as the most primitive member of this clade (Weishampel et al., 1993).

### SOUTH AMERICA

Despite a great wealth of Late Cretaceous dinosaur remains known from the Late Cretaceous of Argentina, hadrosaur remains have been rare. This pattern suggests that, in contrast to the situation in North America, hadrosaurs likely were not the dominant herbivores in South American ecosystems. Brett-Surman (1979) designated *Secernosaurus koernieri* on the basis of incomplete skeletal remains, FMNH P13426, which include a partial braincase, several caudal vertebrae, a scapula, two ilia, a prepubis, and fibula. *S. koernieri* was collected in 1923 by J. B. Abbott for the Field Museum, from the [then] San Jorge Formation, Argentina. Bonaparte et al. (1984) erected *Kritosaurus australis* from materials collected in the Los

Alamitos Formation, Rio Negro, Argentina. Powell (1987) reported new hadrosaurid material from the Lower Member of the Allen Formation, Rio Negro, Argentina, displaying both hadrosaurine and lambeosaurine characters. Powell considers the specimen to represent a lambeosaurine.

### ANTARCTICA

Case et al. (2000) reported the first known occurrence of hadrosaurs from Antarctica. The hadrosaur is represented by a single cheek tooth, MLP 98-I-10-1, and is considered *incertae sedis*.

### CONCLUSION

Hadrosaur research has been a major focus of dinosaur paleontology for the last 150 years. The incredible discoveries associated with these animals have provided the most detailed views of dinosaurian paleoecology yet achieved, and also rank as one of the most diversified groups. Currently, there are 27 valid taxa described from North America, 16 from Asia, two from South America, two from Europe, and one occurrence from Antarctica. This pole-to-pole distribution testifies to the success of hadrosaurs and also alludes to the vast diversity that has yet to be uncovered around the world. Areas expected to produce many new forms of hadrosaurs include Mongolia, Europe, and South America. New taxa are still being discovered in untapped deposits in North America, such as early Campanian formations, like the Foremost and Wahweap formations, and in late Campanian deposits in Mexico. Undoubtedly, future research into hadrosaur taxonomy and paleoecology will utilize these undeveloped areas and shed more light on the hadrosaurian dinosaurs.

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## APPENDIX 1

TABLE 1. Table showing all hadrosauroid and hadrosaurid (following the more inclusive definition from Head [1998]; see Weishampel et al. [1993] and Horner et al. [2004] for more restricted definition) taxa currently known. The type species for each genus is listed first in the species column. The type specimen number and material is intended only for the type species of the genus. † represents taxa considered *nomina dubia*.

Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Amurosaurus</i>	<i>A. riabinini</i> ( <i>Bolotsky and Kurzanov, 1991</i> )	“Amur [region where the type was discovered]”+ <b>Greek:</b> sauros = “lizard”	AEHM 1/12, associated left maxilla and dentary	L. Maastrichtian	<b>Udurchukan Fm.</b> Amur Region, Russia
<i>Anasazisaurus</i> □	<i>A. horneri</i> ( <i>Hunt and Lucas, 1993</i> ) □	“Anasazi [prehistoric people indigenous to Chaco Canyon near type locality]”+ <b>Greek:</b> sauros = “lizard.”	BYU 12950, partial skull	L. Campanian	<b>Kirtland Fm.</b> New Mexico, USA
<i>Anatotitan</i> <sup>1</sup> ( <i>Chapman and Brett-Surman, 1990</i> )	<i>A. copei</i> ( <i>Cope, 1876</i> ) <i>A. longiceps</i> ( <i>Marsh, 1890</i> ) †	<b>Latin:</b> anatos = “duck”+ “Titan = [mythological Greek giant].”	AMNH 5730, complete skeleton	L. Maastrichtian	<b>Hell Creek Fm.</b> Montana, USA South Dakota, USA <b>Lance Fm.</b> Wyoming, USA
<i>Aralosaurus</i> □	<i>A. tuberiferus</i> ( <i>Rozhdestvensky, 1968</i> )	“Aral [Lake Former U.S.S. R.]”+ <b>Greek:</b> sauros = “lizard.”	PIN AN SSR 2229/I, almost complete articulated skull	? Turonian-E. Santonian	<b>Beleutinskiaia Fm.</b> Beleutinskaya Svita Kazachskaya S.S.R.
<i>Bactrosaurus</i> □	<i>B. johnsoni</i> ( <i>Gilmore, 1933</i> ) <i>B. prynadai</i> ( <i>Riabinin, 1939</i> ) † <i>Arstanosaurus akkurganensis</i> ( <i>Shilin and Suslov, 1982</i> ) †	“Bactria [province of Asia]”+ <b>Greek:</b> sauros = “lizard.”	AMNH 6553, partial skull and postcrania	?E. Cenomanian	<b>Iren Debasu Fm.</b> Inner Mongolia, China



Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Barsboldia</i>	<i>B. sicinskii</i> (Maryanska and Osmolska, 1981b)	“Barsbold [Mongolian paleontologist]”	ZPAL MgD-I/110, incomplete postcranial skeleton	?L. Campanian/ Maastrichtian	<b>Nemegt Fm.</b>  Northern Sayr, Nemegt, Mongolia
<i>Brachylophosaurus</i>	<i>B. canadensis</i> (Sternberg, 1953) <i>B. goodwini</i> (Horner, 1988)†	<b>Greek: brachy</b> = “short”+ <b>Greek: lophos</b> = “crest”+ <b>Greek: sauros</b> = “lizard.”	NMC 8893, complete skull, cervical and anterior dorsal vertebrae, ribs, scapulae, coracoids, humeri, left ulna, radius.	L. Campanian	<b>Judith River Fm.</b> Montana, USA <b>Oldman Fm.</b> Alberta, Canada
<i>Claosaurus</i>	<i>C. agilis</i> (Marsh, 1872) <i>C. affinis</i> (Wieland, 1903)†	<b>Greek: klaos</b> = “broken”+ <b>Greek: sauros</b> = “lizard.”	YPM 1190, postcranial skeleton with associated skull fragments	M. Santonian-E. Campanian	<b>Niobrara Chalk</b> Kansas, USA <b>?Pierre Shale</b> South Dakota, USA
<i>Charonosaurus</i>	<i>C. jiyinensis</i> (Godefroit et al., 2000)	“Charon [Boatman on Styx river in Greek and Roman mythology]”+ Greek: sauros = “lizard.”	CUST J-V1251-57, partial skull	L. Maastrichtian	<b>Yuliangze Fm.</b> Heilongjiang Province, China
<i>Corythosaurus</i>	<i>C. casuarius</i> (Brown, 1914) <i>C. intermedius</i> (Parks, 1923) <i>Tetragonasaurus cranibrevis</i> (Sternberg, 1935)	<b>Greek: korythos</b> = “Corinthian [helmet]”+ <b>Greek: sauros</b> = “lizard.”	AMNH 5240, skeleton missing forelimbs and end of tail, with fossilized integument.	M.-L. Campanian	<b>Dinosaur Park Fm.</b> Alberta, Canada
<i>Edmontosaurus</i>	<i>E. regalis</i> (Lambe, 1917b) <i>E. annectens</i> (Marsh, 1892) <i>E. saskatchewanensis</i> (Sternberg, 1926)	“Edmonton [Formation]”+ <b>Greek: sauros</b> = “lizard.”	NMC 2288, skull with jaws, vertebrae to caudal 6, humerus, hindlimb, pubes, ischium, right ilium.	E.-L. Maastrichtian	<b>Hell Creek Fm.</b> Montana, USA North Dakota, USA South Dakota, USA <b>Lance Fm.</b> Colorado, USA <b>Laramie Fm.</b> Wyoming, USA <b>Frenchman Fm.</b> <b>Horseshoe Canyon Fm.</b> <b>Scollard Fm.</b> <b>St. Mary River Fm.</b> Alberta, Canada Saskatchewan, Can

Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Eolambia</i>	<i>E. caroljonesa</i> (Kirkland, 1998)	<b>Greek:</b> eo = “dawn” “Lambia [Lambeosaurinae]”	CEUM 9758, partial adult skull and skeleton	L. Albian-E. Cenomanian	<b>Cedar Mountain Fm.</b> Utah, USA
<i>Equijubus</i>	<i>E. normani</i> (You et al., 2003)	<b>Latin:</b> equus = “horse”+ <b>Latin:</b> juba = “mane”	IVPP V 12534, complete skull and partial postcrania	late E. Cretaceous	<b>Middle grey unit of Xinminbao Group</b> Gansu Province, China
<i>Gilmoreosaurus</i>	<i>G. mongoliensis</i> (Brett-Surman, 1979) <i>G. arkhangel'skyi</i> (Nessov and Kaznyshkina 1995)† <i>G. atavus</i> (Nessov 1995)† <i>Mandschurosaurus</i> <i>mongoliensis</i> (Gilmore, 1933)†	“[Charles Whitney] Gilmore”+ <b>Greek:</b> sauros = “lizard.”	AMNH 6551, incomplete cranial and postcranial skeleton	?Cenomanian- ?Maastrichtian	<b>Iren Dabasu Fm.</b> Nei Mongol, People's Republic of China
<i>Gryposaurus</i>	<i>G. notabilis</i> (Lambe, 1914) <i>G. incurvimanus</i> (Parks, 1920) <i>G. latidens</i> (Horner, 1992) <i>G. sp. nov.</i> (Gates, unpublished data)	<b>Latin:</b> gryphus = “griffin”+ <b>Greek:</b> sauros = “lizard.”	NMC 2278, skull associated incomplete postcranial skeleton.	E. Campanian- L. Campanian	<b>Dinosaur Park Fm.</b> Alberta, Canada <b>Kaiparowits Fm.</b> Utah, USA <b>Two Medicine Fm.</b> Montana, USA
<i>Hadrosaurus</i> <sup>2</sup> †	<i>H. foulkii</i> (Leidy, 1858)† <i>H. tripos</i> (Cope, 1869)† <i>H. minor</i> (Marsh, 1870)† <i>H. cavatus</i> (Cope, 1871)† <i>H. breviceps</i> (Marsh, 1889)†	<b>Greek:</b> hadros = “sturdy”+ <b>Greek:</b> sauros = “lizard.”	ANSP 10005, mandibular teeth, postcrania including 28 vertebrae, humerus, radius, ulna, ilium, ischium, femur, tibia, fibula, two metatarsals.	Campanian	<b>Woodbury Fm.</b> New Jersey, USA
<i>Hypacrosaurus</i>	<i>H. altispinus</i> (Brown, 1912) <i>H. stebingeri</i> (Horner and Currie, 1994)	<b>Greek:</b> hy = “very”+ <b>Greek:</b> akros = “high”+ <b>Greek:</b> sauros = “lizard.”	AMNH 5204, last eight dorsal and two anterior caudal vertebrae, ilia, right ischium, right pubis, several ribs, adult material.	E. Maastrichtian	<b>Horseshoe Canyon Fm.</b> Alberta, Canada <b>Two Medicine Fm.</b> Montana, USA
<i>Jaxartosaurus</i>	<i>J. aralensis</i> (Riabinin, 1939) <i>J. fuyunensis</i> (Wu, 1984)†	“Jaxartes [River in Kazakhstan]” + <b>Greek:</b> sauros = “lizard.”	PIN 1/5009, caudal portion of skull	?Turonian- Santonian	<b>Kyrk-Kuduk Locality</b> Kazakhstan

Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Kerberosaurus</i>	<i>K. manakini</i> (Bolotsky and Godefroit, 2003)	“Kerbreos [Greek mythological monstrous dog]”+ <b>Greek:</b> sauros = lizard	AENM 1/319 caudal portion of skull	L. Maastrichtian	<b>Tsagayan Fm.</b> Amur Region, Russia
<i>Kritosaurus</i>	<i>K. navajovius</i> (Brown, 1910) <i>K. australis</i> (Bonaparte et al., 1984)	<b>Greek:</b> kritos = “separated”+ <b>Greek:</b> sauros = “lizard.”	AMNH 5799, partial skull and lower jaws.	?Campanian-Maastrichtian	<b>Aguja Fm.</b> Texas, USA <b>Kirtland Fm.</b> New Mexico, USA <b>Almos Fm.</b> Coahuila, Mexico <b>San Jorge Fm.</b> Patagonia, Argentina
<i>Lambeosaurus</i>	<i>L. lambei</i> (Parks, 1923) <i>L. paucidens</i> (Marsh, 1889)† <i>L. magnicristatus</i> (Sternberg, 1935) <i>?L. laticaudus</i> (Morris, 1981)	“[Lawrence M.] Lambe”+ <b>Greek:</b> sauros = “lizard.”	NMC 2869, incomplete skull with right mandibular ramus.	Campanian	<b>Dinosaur Park Fm.</b> Alberta, Canada <b>El Gallo Fm.</b> Baja California, Mexico
<i>Lophorhynchon</i>	<i>L. atopus</i> (Langston, 1960)	<b>Greek:</b> lopho = “crested” <b>Greek:</b> thon = “snout”	FMNH P27383, partial skull and post crania	Campanian	<b>Blackcreek Fm.</b> North Carolina, USA <b>Mooreville Chalk</b> Alabama, USA
<i>Maiasaura</i>	<i>M. peeblesorum</i> (Horner and Makela, 1979)	<b>Greek:</b> maia = “good mother”+ <b>Greek:</b> sauros = “lizard.”	PU 22405, skull with partial right dentary an predentary, adult.	L. Campanian	<b>Two Medicine Fm.</b> Montana, USA
<i>Naashoibitosaurus</i> <sup>3</sup>	<i>N. ostromi</i> (Hunt and Lucas, 1993)	“De-na-zin [Member of Kirtland Formation]”+ <b>Greek:</b> sauros = “lizard.”	NMMNH P - 16106, incomplete skull and postcrania.	L. Campanian	<b>Kirtland Fm.</b> New Mexico, USA
<i>Nipponosaurus</i>	<i>N. sachalinensis</i> (Nagao, 1936)	<b>Japanese:</b> nippon = “Japan”+ <b>Greek:</b> = “lizard”	UHR 6590, left posterior skull and partial skeleton	L. Santonian- E. Campanian	<b>Upper Yezo Group</b> Sinegorsk, South Sakhalin, Russia
<i>Olorotitan</i>	<i>O. arharensis</i> (Godefroit et al., 2003)	<b>Latin:</b> olor = “swan”+ <b>Greek:</b> titan = “giant”	AEHM 2/845, partial skull and associated postcrania	L. Maastrichtian	<b>Tsagayan Fm.</b> Amur Region Russia
<i>Pararhabdodon</i>	<i>P. isonensis</i> (Casasnovas et al., 1993)	<b>Greek:</b> para = “similar to”+ “Rhabdodon [a genus of Ornithomimid dinosaur from Europe]”	IPS-SRA 1, mid-cervical vertebra	L. Campanian-Maastrichtian	<b>Sant Roma d’Abella Fm.</b> Lleida, Spain

Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Parasaurolophus</i>	<i>P. walkeri</i> (Parks, 1922) <i>P. tubicen</i> (Wiman 1931) <i>P. cyrtocristatus</i> (Ostrom 1961)	<b>Greek:</b> <i>para</i> = “similar”+ <b>Greek:</b> <i>sauros</i> = “lizard”+ <b>Greek:</b> <i>lophus</i> = “crest”	ROM 768, skull, postcranial skeleton including trunk, forelimb, pelvis, femur.	L. Campanian	<b>Dinosaur Park Fm.</b> Alberta, Canada <b>Fruitland Fm.</b> New Mexico, USA <b>Kaiparowits Fm.</b> Utah, USA <b>Kirtland Fm.</b> New Mexico, USA
<i>Penelopognathus</i>	<i>P. weishampeli</i> (Godefroit et al., 2005)	<b>Greek:</b> <i>penelops</i> = “wild duck”+ <b>Greek:</b> <i>gnathos</i> = “jaw”	IMM 2002-BYGB-1, right dentary	Albian	<b>Bayan Gobi Fm.</b> Urad Houqi Banner, Inner Mongolia, P.R. China
<i>Prosaurolophus</i>	<i>P. maximus</i> (Brown, 1916) <i>P. blackfeetensis</i> (Horner, 1992)	<b>Greek:</b> <i>pro</i> = “before”+ <b>Greek:</b> <i>sauros</i> = “lizard”+ <b>Greek:</b> <i>lophus</i> = “crest”	AMNH 5386, incomplete skull with jaws.	L. Campanian	<b>Two Medicine Fm.</b> Montana, USA <b>Dinosaur Park Fm.</b> Alberta, Canada
<i>Protohadros</i>	<i>P. byrdi</i> (Head, 1998)	<b>Greek:</b> <i>proto</i> =“first”+ <b>Greek:</b> <i>hadros</i> = “sturdy [for Hadrosauridae, indicating phylogenetic status].”	SMU 74582, nearly complete skull and isolated postcrania	Cenomanian	Woodbine Fm. Texas, USA
<i>Saurolophus</i>	<i>S. osborni</i> (Brown, 1913) <i>S. angustirostris</i> (Rozhdestvensky, 1952) <i>S. krischtofovici</i> (Riabinin, 1930)†	<b>Greek:</b> <i>sauros</i> = “lizard”+ <b>Greek:</b> <i>lophus</i> = “crest”	AMNH 5220, nearly complete skeleton with skull, integument.	E. Maastrichtian	<b>Horseshoe Canyon Fm.</b> Alberta, Canada <b>Nemegt Fm.</b> Mongolia
<i>Secernosaurus</i>	<i>S. koerneri</i> (Brett-Surman, 1979)	<b>Latin:</b> <i>secerno</i> = “sever of divide” + <b>Greek:</b> <i>sauros</i> = “lizard”	FMNH P13423, partial postcrania	Cenomanian-Coniacian	<b>San Jorge Fm.</b> Patagonia, Argentina
<i>Shantungosaurus</i>	<i>S. giganteus</i> (Hu, 1973)	“Shantung [Region of type discovery”+ <b>Greek:</b> <i>sauros</i> = “lizard”	IVPP V1780, partial skull	Campanian	<b>Wangshi Group</b> P.R. China
<i>Telmatosaurus</i>	<i>T. transsylvanicus</i> (Nopcsa, 1903)	<b>Greek:</b> <i>telmato</i> = “marsh” + <b>Greek:</b> <i>sauros</i> = “lizard”	BMNH R3386, fairly complete skull	U. Maastrichtian	<b>Sinpetru and Densus-Ciula Fms.</b> Judetul, Romania
<i>Tsintaosaurus</i>	<i>T. spinorhinus</i> (Young, 1958)	“Tsingtao [City near type specimen locality]” <b>Greek:</b> <i>sauros</i> = “lizard”	IVPP V725, posterior cranium	?Campanian	<b>Wangshi Group</b> P.R. China

Genus	Species	Etymology	Type specimen	Age	Biostrat/ Biogeography
<i>Tanius</i>	<i>T. sinensis</i> (Wiman, 1929) <i>T. chingkankouensis</i> (Young, 1958)†	<b>Latin:</b> tanius = “after Tanka people of southern China”	PMU R240, partial skull	Campanian	<b>Wangshi Group</b> P.R. China
Unnamed lambeosaur	(Gates et al., 2005)		SEPCCP1/406, Partial skull	L. Campanian	Cerro del Pueblo Fm. Coahuila, Mexico

1. Brett-Surman (1979) collapsed all species of *Anatosaurus* (Lull and Wright, 1942) into *Edmontosaurus* with the exception of *A. copei*. *Anatosaurus* was subsequently renamed *Anatotitan* (Chapman and Brett-Surman, 1990). 2. Prieto-Marquez et al. (2006) declared the genus *Hadrosaurus* a nomen dubium because the type specimen and all constituent species are non-diagnosable. 3. Horner et al. (2004) consider this genus as *Kritosaurus navajovius* and the latter taxon a nomen dubium.

TABLE 2. Table cross-referencing country with all currently recognized hadrosaur taxa found within its borders.

Country	Hadrosaur taxa discovered
Argentina	<i>Secernosaurus koeneri</i> (Brett-Surman, 1979) <i>Kritosaurus australis</i> (Bonaparte et al., 1984)
Canada	<i>Brachylophosaurus canadensis</i> (Sternberg, 1953) <i>Corythosaurus casuarius</i> (Brown, 1914) <i>Edmontosaurus regalis</i> (Lambe, 1917a) <i>Edmontosaurus saskatchewanensis</i> (Sternberg, 1926) <i>Gryposaurus incurvimanus</i> (Parks, 1920) <i>Gryposaurus notabilis</i> (Lambe, 1914) <i>Hypacrosaurus altispinus</i> (Brown, 1912) <i>Lambeosaurus lambei</i> (Parks, 1923) <i>Lambeosaurus magnicristatus</i> (Sternberg, 1935) <i>Parasaurolophus walkeri</i> (Parks, 1922) <i>Prosaurolophus maximus</i> (Brown, 1916) <i>Saurolophus osborni</i> (Brown, 1913)
China	<i>Bactrosaurus johnsoni</i> (Gilmore, 1933) <i>Charonosaurus jiayinensis</i> (Godefroit et al., 2000) <i>Equijubis normani</i> (You, 2003) <i>Gilmoreosaurus mongoliensis</i> (Gilmore, 1933; Brett-Surman, 1979) <i>Penelopognathus weishampeli</i> (Godefroit et al., 2005) <i>Shantungosaurus giganteus</i> (Hu, 1973) <i>Tanius sinensis</i> (Wiman, 1929) <i>Tsintaosaurus spinorhinus</i> (Young, 1958)
Japan	<i>Nipponosaurus sachalinensis</i> (Nagao, 1936)
Kazakhstan	<i>Aralosaurus tuberiferus</i> (Rozdestvensky, 1968) <i>Jaxartosaurus aralensis</i> (Riabinin, 1939)
Mexico	<i>Kritosaurus sp.</i> (Kirkland et al., this volume) Unnamed lambeosaur (Gates et al., 2005)

TABLE 2 (cont.) Table cross-referencing country with all currently recognized hadrosaur taxa found within its borders.

<b>Country</b>	<b>Hadrosaur taxa discovered</b>
Mongolia	<i>Barsboldia sicinskii</i> (Maryanska and Osmolska, 1981b) <i>Saurolophus angustirostris</i> (Rozdestvinsky, 1952)
Romania	<i>Telmatosaurus transsylvanicus</i> (Nopsca, 1903)
Russia	<i>Amurosaurus rabinini</i> (Bolotsky and Kurzanov, 1991) <i>Kerberosaurus manakini</i> (Bolotsky and Godefroit, 2004) <i>Olorotitan arharensis</i> (Godefroit et al., 2003)
Spain	<i>Pararhabdodon isonensis</i> (Cassanovas et al., 1993)
United States	<i>Anasazisaurus horneri</i> (Hunt and Lucas, 1993) <i>Anatotitan copei</i> (Chapman and Brett-Surman, 1990) <i>Brachylophosaurus canadensis</i> (Sternberg, 1953) <i>Claosaurus agilis</i> (Marsh, 1872) <i>Edmontosaurus annectens</i> (Marsh, 1892) <i>Eolambia caroljonesa</i> (Kirkland, 1998) <i>Gryposaurus latidens</i> (Horner, 1992) <i>Hypacrosaurus stebingeri</i> (Horner and Currie, 1994) <i>Kritosaurus navajovius</i> (Brown, 1910) <i>Lophorothon atopus</i> (Langston, 1960) <i>Maiasaura peeblesorum</i> (Horner and Makela, 1979) <i>Naashoibitosaurus ostromi</i> (Hunt and Lucas, 1993) <i>Parasaurolophus cyrtocristatus</i> (Ostrom, 1961) <i>Parasaurolophus tubicen</i> (Wiman, 1931) <i>Protohadros byrdi</i> (Head, 1998)