Occurrence of the musk ox, *Symbos cavifrons*, from southeastern Idaho and comments on the genus *Bootherium*

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OCCURRENCE OF THE MUSK OX, SYMBOS CAVIFRONS, FROM SOUTHEASTERN IDAHO AND COMMENTS ON THE GENUS BOOTHERIUM

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ABSTRACT—A set of ovibovine horn cores collected from Pleistocene sediments in southeastern Idaho provides additional evidence for sexual dimorphism in the helmeted musk ox, *Symhos cavifrons*. Specimens previously assigned to *Bootherium sargenti* are placed in synonymy with *Symhos cavifrons* as sexual dimorphs (females). *Bootherium bombifrons* is a valid taxon and is probably not closely related to *Symhos*.

The taxonomic status of the extinct musk ox, *Bootherium*, has been questioned since Leidy (1852a, 1852b) proposed the name for two extinct species of ovibovines, *B. bombifrons* (*Bos bombifrons* of Harlant 1825, Wistar 1818) and *B. cavifrons*. Later, Dawkins (1867) and then Leidy (1869) synonymized these extinct forms with the extant musk ox, *Ovis*.*Osgood* (1905a) erected the genus *Scaphoceros* for a musk ox, *S. tyrrelli*, collected from the Yukon Territory of Canada but later discovered that *Scaphoceros* was preoccupied; he therefore replaced it with the name *Symhos* (1905b). In addition, Osgood (1905a, 1905b) observed that *Symhos cavifrons* and *Bootherium bombifrons* were distinct species and definitely separable from the extant *Ovis moschatus*. Gidley (1908) named a second species of *Bootherium*, *B. sargenti*, from a late-Pleistocene deposit in Michigan.

Taxonomists (see Kurten and Anderson 1950) now generally agree that all extant musk ox belong to *Ovis moschatus* and that the various proposed species of *Symhos*, e.g., *S. tyrrelli* Osgood, *S. australis* Brown, *Liops zuniensis* Gidley (preoccupied, changed to *Lissops zuniensis* Gidley), and *Gidleya zuniensis* (Cossman) are all assignable to *Symhos cavifrons* (for a different opinion see McDonald 1985). However, the taxonomic status of *Bootherium* remains in question.

Confusion surrounding *Bootherium* has arisen from the supposed sex of various *Bootherium* and *Symhos* skulls. Is *Bootherium* a female *Symhos*? Rutimeyer (1867), on the basis of Leidy’s (1852a, 1852b) figures and descriptions, pronounced that *Bootherium cavifrons* (= *Symhos cavifrons*) was a male and *B. bombifrons* a female. He then assigned these specimens to a new taxon, *Ovis priscus*. Dawkins (1872) came to a similar conclusion but chose to call the duo *Ovis cavifrons*. Lydekker (1855, 1898) was also convinced that *B. bombifrons* and *B. cavifrons* (= *S. cavifrons*) were sexual dimorphic forms of the same species.

Osgood (1905a), as Allen (1913) so aptly stated, set forth the real facts of the case. . . . Since *bomifrons* and *cavifrons* have been considered by several authors as being not only congeneric, but conspecific, the establishment of a separate genus for each may appear surprising. While it may be possible, from an examination of the figures only, to construct a hypothesis to the effect that *cavifrons* represents the male and *bomifrons* the female of one species, it is inconceivable that any modern taxonomist would reach such a conclusion after comparing the original types.

Allen (1913) certainly agreed when he stated, Upon carefully reading Osgood’s paper I felt sure that he had correctly solved the problem.

Evidently Hay (1924) did not believe the problem had been solved and did not accept this opinion [of Allen and Osgood].” Hay believed that some of the 25 skulls of *Symhos cavifrons* that he examined “must have been females.”

*Bison appalacicus*, originally named by Rhoads (1895), was assigned to *Bootherium appalacicus* by Ray (1966a) and described as “closely related, if not conspecific” with *Bootherium sargenti*. *Bootherium nicolences* was erected by Hay (1913) for a specimen from

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239
Eschscholtz Bay, Alaska, while Hesse (1942) named *Bootherium brazosis* from Brazos County, Texas. The latter has been identified by Ray (1966b) as conspecific with *Bootherium sargenti*.

Hibbard and Hinds (1960) reported,

It is very likely that *Bootherium* is the female woodland musk ox since all specimens of *Symbos* based on skulls are considered those of bulls.

Evidently Hibbard and Hinds examined the type of *B. sargenti* and made their decision on the basis of this specimen. It is not known if they intended to also include *B. bombifrons* as a female *Symbos*.

Semken et al. (1964) reviewed the literature and decided

that *Bootherium bombifrons* represents a genus distinct from *Symbos*. However, *B. sargenti*, the specimen examined by Hibbard and Hinds (1960), may be a female *Symbos*.

Ray et al. (1967) excavated an ovibovine cranium from Saltville, Virginia, that was assigned to *Bootherium* sp. indet., and stated that

the specific taxonomy (not to mention the generic status) of *Bootherium* is not yet well understood.

Nelson and Madsen (1978) documented the existence of 21 individual musk ox from late-Pleistocene sediments of Utah. They assigned the four specimens of *Bootherium* to *Bootherium* sp. indet., although Stokes and Hansen (1937) had previously assigned one specimen (BYUG 834) to *B. bombifrons*.

Harington (written communication 1978) synonymized *Bootherium nivicolens* with *B. sargenti*. He also believed that *B. sargenti* was probably the female of *Symbos cavifrons* because the differences between the specimens parallel the morphological differences between male and female specimens of *Ovibos moschatus*.

In Kurten and Anderson's (1980) summarization of Pleistocene mammals of North America, *Bootherium sargenti* and *Symbos cavifrons* were synonymized, while the type specimen of *B. bombifrons* was questionably left as a separate species.
White (personal communication 1984, 1985) reviewed the musk ox of Idaho and concluded that two cranial fragments of *Bootherium* collected from Pleistocene sediments in Idaho (IMNH 68001; LACM 6671) could not be assigned with confidence to established species. However, the size of the cranial fragment (LACM 6671) collected from Minidoka Dam "suggests it may be referable to *B. sargenti*.”

J. N. McDonald (Radford University) is studying a mummified specimen of *Bootherium* collected from a permafrost locality at Fairbanks Creek, Alaska (F:AM A-293-5286). Other than a preliminary report (McDonald 1984), little has been published on this interesting specimen.

Institutional abbreviations are as follows:

- UVP- Utah Division of State History, Antiquities Section, Vertebrate Collection
- UUVP- University of Utah, Vertebrate Paleontology Collection
- IMNH- Idaho Museum of Natural History
- KUVP- Kansas University, Vertebrate Paleontology Collection
- LACM- Los Angeles County Museum of Natural History
- GRPM- Grand Rapids Public Museum
- ANSP- Academy of Natural Sciences of Philadelphia
- TAMC- Texas A & M University Collection
- BYUVP, BYUG-Brigham Young University, Vertebrate Paleontology Collection
- USU- Utah State University, Geology Collection
- USNM- United States National Museum of Natural History
- F:AM- Frick Collection, American Museum of Natural History

**Collection Background**

In 1980 Chris and Jack Dukes of Salt Lake City, Utah, brought a partial cranium with a complete, although broken, set of horn cores to the Antiquities Section of the Utah Division of State History. A laboratory assistant labeled the specimen "Bison, collected from Idaho" and entered the specimens into the collections. In examining these collections during the winter of 1985, we recognized the horn cores as ovibovine and not bison. The horn cores resembled the numerous horn cores of *Symbos cavifrons* in the Division of State History and Utah Museum of Natural History collections, but the frontal area of the cranium lacked the characteristic exostosis and median cranial sulcus of *Symbos*. Comparisons with Utah specimens of *Bootherium* revealed no close resemblances. This discovery prompted a review of all Utah and Idaho musk ox specimens and ultimately led to the preparation of this report.

**Age and Stratigraphy**

Precise locality information and stratigraphic data were garnered after the discov-
Fig. 3. Bootherium bombyfrons, USNM 215066 (cast), original ANSP 2994, right lateral view. Bar represents 10 cm.

The Dam local fauna (IMNH locality 52002), described from a gravel quarry located between the present American Falls townsite and the east end of the American Falls Dam (Hay 1927, Gazin 1935, Hopkins 1951, 1955, Hopkins, Bonnichsen, and Fortsch 1969, Barton 1976, White 1985), was collected approximately 200 m southwest of the elevator construction site. Among other fossils collected by Gazin (1935), White (1985) listed a number of specimens of Symbos cavifrons obtained from a pit in the American Falls Formation. A radiocarbon date on in situ bone fragments from the locality yielded a date of 26,500 ± 3,500 y.b.p. (Barton 1976). White (1985) believed the Dam L.F. was correlative with the “B layer” of Hopkins, Bonnichsen, and Fortsch (1969) and the Rainbow Beach section of McDonald and Anderson (1975).

Field relationships indicate that the new musk ox specimen (UVP 083) was collected from the same sediments as the Dam L.F. and is therefore a part of the Dam L.F.

**Systematic Paleontology**

**Order Artiodactyla**

**Family Bovidae**

**Genus Symbos** Osgood 1915

Symbos cavifrons (Leidy) 1852

- Bootherium bombyfrons Leidy 1852 (in part)
- Ovibos cavifrons Dawkins 1883, Leidy 1869, Lydekker 1885, McGee 1887 (in part)
- Bison appalachicus Rhoads 1895
- Ovibos cavifrons Hatcher 1902
- Scaphoceros tyrrelli Osgood 1905
- Symbos tyrrelli Osgood 1905 (Scaphoceros preoccupied)
- Gilleya zuniensis Cossmann 1907
- Lissops zuniensis Gilley 1908 (Liops preoccupied)
- Symbos australis Brown 1908
- Bootherium sargentii Gilley 1908
- Ovibos appalachicus Staudinger 1905, Allen 1913, Hay 1923, Frick 1937, Kitts 1953
- Bootherium nivicolum Hay 1915
- Symbos promptus Hay 1920
- Symbos convexifrons Barbour 1934
- Ovibos giganteus Frick 1937
Fig. 4. *Symbos cavifrons*, UUVP 8540, dorsal view. Bar represents 10 cm.

*Bootherium brazosis* Hesse 1942
*Bootherium appalachicohis* Ray 1966
*Bootherium* sp. indet. Nelson and Madsen 1978 (in part)
*Bootherium* sp. White 1985 (in part)

**Material** — UVP 083, cranial cap including both horn cores.

**Description** — UVP 083 consists of a complete set of horn cores attached to the frontals and the cranial cap (Fig. 1). Very little of the cranium is preserved anterior or posterior to the attachment of the horn cores. The horn cores curve outward, downward, and forward with a high lateral flare and are very similar to the curvature on *Symbos* skulls that are thought to be males. However, the horn core tips of male *Symbos* skulls drop to a position that nears the base of the skull (Fig. 2). The horn cores on UVP 083 tend to flare out in a lateral direction and do not extend much below the orbits. This curvature contrasts with the horn core curvature seen in *Bootherium bombifrons*, where the horns flare only slightly outward and then drop sharply downward and finally forward (Fig. 3).

The horn cores in UVP 083 slightly overlap the frontals as on male *Symbos* skulls (Fig. 4). However, there is an absence of an exostosis and cranial sulcus, and the area on the frontals and parietals between the proximal borders of the horn cores is smooth (Fig. 1). A slightly elevated anterior-posterior ridge extends along the midline of the frontals.

A burr is neither present on the horn cores nor do the horn cores stand out on pedicles as in *Bootherium*. The horn cores are flattened on the dorsal surface near the proximal border. This condition is reflected in male *Symbos* horn cores and stands in contrast with the
The horn cores exhibit a sculpturing that is very similar, if not identical, to several male *Symbos* specimens in the Utah Division of State History and Utah Museum of Natural History collections. Evident are a series of grooves which tend to wrap around in a counterclockwise direction as they descend down the horn core. Although not continuous, the grooves extend to the very tip of the cores (Figs. 1, 4).

The thickness of the cranial roof does not vary appreciably anteriorly (62 mm) or posteriorly (58 mm) from the horn cores. However, there is a distinct difference in the type of bone present in the cranial cap. Anterior to the horn cores, the cranium is composed of highly vacuolate bone. Posterior, the entire cranial roof is constructed of finely cancellous bone. This spongy bone is similar to that observed on male *Symbos* skulls but absent in specimens of *Bootherium bombifrons*.

**Discussion.**—Harington (*fide* Kurten and Anderson 1980:332) believed the evidence supporting the female *Symbos* designation of the type specimen of *Bootherium sargenti* quite compelling. He noted, according to Kurten and Anderson, the similar basic confirmation of the horn-cores, the smaller size of the cranium, and the broad space between the horn-core bases parallels the differences between male and female *Ovibos moschatus*.

The sexual dimorphism in modern specimens of *Ovibos moschatus* is clearly noted in
cleaned skulls, although it is not apparent in living specimens. In male specimens of *Ovibos* "the base of the horn-core is enlarged and expanded over a great part of the frontals and parietals, on which large exostoses are developed" (Lonnberg 1900). However, there is a very characteristic medial groove that separates the horn cores (Fig. 5). In examining skulls of female *O. moschatus*, we have found that the horn cores are much more widely separated at the bases and the frontals are nearly smooth between the horn cores. There are no large exostoses developed (Fig. 6). In addition, the horn cores of the females are not as massive as those of the male. This difference then, between male and female *O. moschatus* specimens, is very similar to the morphological differences noticed in specimens of "Bootherium sargenti" and *Symbos cavifrons*.

UVP 083 is almost identical to KUVP 61635, a set of horn cores and associated partial skull from Natural Trap Cave in northwestern Wyoming (Neas, personal communication 1981) (Fig. 7). This latter specimen has stockier and somewhat shorter horn cores than UVP 083 but morphologically agrees in all other details. The sculpturing is similar, the cancellous bone is present, the horn cores slightly overlap the frontals, the frontals are smooth between the horn cores, and a slightly elevated mid-frontal ridge is present. Neas (personal communication 1985) believes that the Natural Trap cave specimen may represent a female *Symbos*.

The Wyoming (KUVP 61635) and Idaho specimens (UVP 083, LACM 6671) also appear to be very similar, if not almost identical, to the type of *Bootherium sargenti* from Michigan (GRPM 114233101) described by Gidley (1908) (Figs. 8, 9). Therefore, we agree with the suggestions of Allen (1913), Hibbard and Hinds (1960), Semken, Miller, and Stevens (1964), and Kurten and Anderson (1980) and hereby propose that *Bootherium sargenti* (GRPM 114233101), *B. appalachicolus* (ANSP 29, placed in synonymy with *B. sargenti* by Ray, 1966a), *B. brazos* (TAMC 2553, placed in synonymy with *B. sargenti* by Ray, 1966b), *B. nivicolaens* (USNM 2324,
placed in synonymy with *B. sargenti* by Harington, written communication 1978), and *Bootherium* sp. (LACM 6671, White 1985) be included with *Symbos cavifrons* as sexual dimorphic forms. Other specimens would also include KUVP 61635 (Neas, personal communication 1985), BYUVP 9278 (Nelson, unpublished information), and the Idaho specimen in this discussion, UVP 083.

**Status of Bootherium**

Kurten and Anderson (1980) and Harington (written communication 1978) believe that *Bootherium bombifrons* is a valid taxon “presuming the type . . . does not represent an abnormal individual.” A reexamination of the Pleistocene specimens from Utah confirms the taxonomic validity of this determination.

USU 3529 is a partial cranium collected from the late-Pleistocene shoreline deposits of Lake Bonneville in northern Utah (Nelson and Madsen 1978) (Fig. 10). Although the skull is incomplete, there are sufficient diagnostic characters present to assign it to *Bootherium*. The horn cores stand out from the skull on a pedicel and display a distinct burr at the proximal border. They are
rounded in cross section and are unflattened dorsally near their bases. An exostosis and cranial sulcus are lacking, and the frontals between the horn cores are smooth. Perhaps, and most importantly, there is a very abrupt posteroventral slope of the dorsal outline of the skull posterior to the horn cores. This sloping area is a very diagnostic feature on the
type specimen of *B. bombifrons*: the horn cores seem to be placed on the summit of the skull very similar to the condition in goats and sheep, but unlike *Symbos* (Fig. 11).

Although the ventral part of this skull is abraded, sufficient detail is present to permit identification of the characteristic basisphenoid area. In *Bootherium* the
proximal end of the basisphenoid is dorsally deflected from the basioccipital at a very low angle (less than 20 degrees). In Symbos this deflection is greater than 35 degrees (White, personal communication 1984).

A second Bootherium skull from Utah (BYUG 834) is quite similar to USU 3529 in most characteristics (Fig. 12). The single, major difference is in the length of the sloping skull cap posterior to the horn core attachment. In BYUG 834 this length is only about 90% of the length of USU 3529. However, this difference may be attributable to post mortem abrasion of the skull rather than to pathology, individual variation, or sexual dimorphism.

Both Utah specimens (BYUG 834 and USU 3529) of Bootherium may now be assigned with certainty to B. bombifrons. They, but especially USU 3529, are almost identical to the type specimen of B. bombifrons in size and morphological characteristics. A second specimen of Bootherium in the Brigham Young University collections could not be located (Nelson and Madsen 1978), but photographic evidence suggests that it too is B. bombifrons. UUVP 8532, described by Nelson and Madsen (1978), also appears assignable to B. bombifrons, but post mortem abrasion of the specimen makes this latter identification more tenuous.

A specimen, IMNH 17124, which was collected from Bannock County, Idaho, and described by White (1985) as Bootherium sp., is difficult to place specifically (Fig. 13). It exhibits all of the characteristics of Bootherium bombifrons (see White 1985 for a description), with the exception of the length of the skull cap posterior to the horn core attachment (Fig. 14). In IMNH 17124 the cranial cap slopes abruptly downward at a much greater angle than in B. bombifrons. In addition, the length of the cranium posterior to the horn cores is 30% shorter than comparable specimens of B. bombifrons. This specimen may represent a pathological individual, a new species of Bootherium, an individual variant, or a sexual opposite from that of the type specimen of B. bombifrons. The gracile nature of this specimen suggests the latter choice, with IMNH 17124 representing a female.
Fig. 14. A, *Bootherium bombifrons*, USNM 215066 (cast), original ANSP 2994, right dorsolateral view; B, *Bootherium* sp. indet., IMNH 17124, right dorsolateral view. Bar represents 10 cm.

**Summary**

In summary, we assert that UVP 083 is inseparable from *Bootherium sargenti*, which in turn is placed in synonymy with *Symbos cavifrons*. These are sexual dimorphic forms, and it is likely that the typical *S. cavifrons* specimens are males whereas the “*B. sargenti*” forms are females. *Bootherium bombifrons* is a valid taxon and is probably not closely related to *S. cavifrons*.

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