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SUPPLEMENTARY ONLINE MATERIAL FOR

**A roe deer from the Pliocene of Hidalgo, central Mexico**

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**Supplementary Online Material**

**SOM 1.** Recent American cervid specimens used for comparison.

**SOM 2.** Detailed morphological comparison between the cervid specimens from the Pliocene of Amajac, Hidalgo, *Capreolus capreolus* and the Recent American cervids.

**Figure 1.** Diagrammatic p4 of selected New World cervids

**References**

## **SOM 1. Recent American cervid specimens used for comparison**

Specimens used for comparison include a skeleton of *Odocoileus virginianus* (LCBE 0001); mandibles and postcranials of *O. virginianus* (INAH 663, INAH 1183, INAH 16897), *O. hemionus* (INAH 1275), *Cervus canadensis* (INAH 1227), and *Navahoceros fricki* (INAH 1007, INAH 1082, INAH 1116, INAH 1177). We also compared the studied specimens with mandibles with teeth of *Hippocamelus antisensis* (MCN-UNSa 02, MCN-UNSa 03, MACN 53.60) and mandibles of *H. bisulcus* (1364 MLP zool, 10.VIII.00.30 MLP).

Comparisons were also made with cranial, dental, and skeletal material belonging to the european roe deer *Capreolus capreolus* (unnumbered specimens), housed in the IPHES and with published descriptions and illustrations of specimens housed at GIN of *Capreolus constantini*.

*Institutional abbreviations.*—INAH, Colección Osteológica del Laboratorio de Arqueozoología, Instituto Nacional de Antropología e Historia, México; IPHES, Institut Català de Paleoecologia Humana i Evolutio Social, Tarragona, Spain; LCBE, Laboratorio de Colecciones Biológicas, campus Puerto Escondido, Universidad del Mar (UMAR); MACN, Museo Argentino de Ciencias Naturales; MCN-UNS, Colección del Museo de Ciencias Naturales de la Provincia de Salta, Universidad Nacional de Salta, Argentina; MLP, Colección de Mastozoología de la Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Argentina; UAHMP, Museo de Paleontología, Centro de Investigaciones Biológicas, Universidad Autónoma del Estado de Hidalgo.

## **SOM 2. Detailed morphological comparison between the cervid specimens from the Pliocene of Amajac, Hidalgo, *Capreolus capreolus* and the Recent American cervids**

The fossil specimens from Mexico share with those of *Capreolus capreolus* from Tarragona, Spain: the p3s has an anterior styloid, a deep v-shaped anterior valley, a narrow and oblique posterior valley, and an oblique back valley almost closed by the union of the posterior cristid and posterior styloid (Figs. 3, 4A–C); a well molarized and bilobed p4 (Lister et al. 1998); a p4 with an anterior styloid; the presence of a connected anterior and posterior valley in p4 (Figs. 3, 4A–C; SOM Fig. 1); a narrow and oblique back valley; an almost absent and narrow posterior valley; the presence of a v-shaped notch between the mesolabial and the posterolingual conids in the p4 and a transverse cristid that does not fuses with the

mesolingual conid but that forms a posterolingually directed projection that is close to the posterolingual cristid (Figs. 3, 4A–C; SOM Fig. 1).

Additional similarities include a shallow mandible in both Mexican and Spain specimens and a p2-p4/m1-m3 ratio of 0.728 in UAHMP 481, which is within the reported range of 0.68-0.74 for *Capreolus* (Lister et al. 1998).

In regard to postcranial bones, in the tibia, the cnemial crest of UAHMP 486 gently finishes towards its distal end and the popliteal scar is prominent as was observed in recent *Capreolus*, contrasting with the abrupt finishing of the cnemial crest observed in *Odocoileus*.

The metacarpal UAHMP 488 has a fused distal notch, as in *Capreolus* metacarpals, contrasting with the unfused intertrochlear notches of *Odocoileus*, *Hippocamelus*, and *Cervus* (Morejohn and Dailey 2004).

The proximal phalanx from Amajac is stout and has a well-developed distal trochlea, similar to the observed phalanx of *Capreolus* from Spain; this contrasts with the phalanges of *Odocoileus*, which are more slender and with a less developed distal trochlea.

Comparison between the Pliocene specimens from Hidalgo and those of Recent American cervids revealed significant differences between them.

In *Odocoileus virginianus* and *O. hemionus* specimens from INAH and UMAR the p3 and p4 are subequal in length, while in the mandible from Amajac the p4 is longer. The p3 of *Odocoileus* has a better-developed mesolabial conid than in the studied specimen and has little or no development of the anterolingual and posterolingual cristids, while in the Hidalgo specimens they are well developed in slightly worn teeth. The p4 of *Odocoileus* is anteroposteriorly shorter than the Hidalgo specimen (Fig. 4D–E).

In slightly worn p4 of *O. virginianus* (INAH 16897) the transverse cristid is lingually oriented and it still does not close the anterior valley (Fig. 4D), the anterolingual cristid still does not fuse with the anterior conid -leaving open the anterior valley- and the posterolingual conid and posterolabial conid still are not connected (Fig. 4D). With additional wear (observed in INAH 663), the transverse cristid fuses with the mesolingual conid, closing the anterior valley; also, the posterolingual conid and posterolabial conid are connected (Fig. 4E). A closed anterior valley and connected posterolingual and posterolabial conids is the typical condition observed in *Odocoileus* (Fig. 5A) (Janis and Lister 1985; Webb 2000). In very worn teeth the back valley can also be occasionally closed (SOM Fig. 1) as was observed in LCBE 0001.

Moreover, the p3 and p4 of the examined *Odocoileus* specimens are about 17–22% smaller than the Amajac specimens. Their mandibles have a similar depth that of UAHMP 481.

*Navahoceros fricki* specimens from INAH are about 45% larger than the Pliocene specimens from Amajac; their p3 is larger than the p4 and their p3 has little or no development of the anterolingual and posterolingual cristids, contrary to the observed in the fossil p3s (Fig. 4F). The mandibles of *N. fricki* are stouter and slightly deeper than UAHMP 481.

In the well-worn p3 (INAH 1082) the posterior valley is closed by the fusion of the posterolingual cristid and the posterolingual conid (Fig. 4F), forming a fossettid. The moderately worn p4 of *N. fricki* (INAH 1116) is like that of *O. virginianus*, with a closed anterior valley, an open posterior and back valley and a U-shaped notch between the mesolingual and the posterolabial conid, but it is different from the studied Pliocene premolar from Amajac (Fig. 4F). The p4 of *Navahoceros* is so molarized in some specimens (like INAH 1082) that it closely resembles a true molar, even closing the back valley (Fig. 4F; SOM Fig. 1).

In the examined *Cervus canadensis* specimen (INAH 1227) the p3 and p4 also are subequal in length, the p3 has a comparatively wider anterior and posterior valleys than the fossil specimens and it has little or no development of the anterolingual and posterolingual cristids. The p4 has a well-developed anterior styloid; their connections of cristids and conids are similar to that of *Odocoileus* (Fig. 4G), with a closed anterior valley and an oblique posterior and back valley (SOM Fig. 1). The *Cervus* specimen is about 50% larger than the studied specimens and its mandible is stouter.

The *Hippocamelus* specimens are about 18.5% larger than the studied specimens; their p3 and p4 are subequal in length, while in the Amajac specimen p4 is the largest. The p3 of *Hippocamelus* lacks or has little development of the anterolingual and posterolingual cristids and their molars have better developed ribs and styloids than those of UAHMP 481 (Fig. 4H).

Mandibles of *H. antisensis* are similar in depth and proportions to UAHMP 481 but those of *H. bisulcus* are stouter.

In slightly worn p3 of *H. bisulcus* (1364 MLPzool), the mesolingual conid is thin, lacking the posterolingual cristid (Fig. 4H), contrary to the observed in UAHMP 432. The anterolingual cristid of the slightly worn p4 does not reach the anterior conid, leaving the anterior valley open (Fig. 4H; SOM Fig. 1) and the posterior and back valleys are wider than those of the p4 from Amajac.

In *H. antisensis* (MCN-UNSa03) with additional wear, the p4 looks similar to that of *Cervus*, with an anterior fossettid produced by the closure of the anterior valley, and an oblique posterior and back valleys (Fig. 4G; SOM Fig. 1).

Mandibles of *Mazama* are shallower than UAHMP 481 and between 34% (*M. rufina*) to 38% smaller (*M. americana*), whilst those of *Pudu* are about 42% smaller (HersHKovitz 1982). The p3 and p4 of these genera are sub-equal in length while in UAHMP 481 the p4 is larger than the p3. According to the species, the p3 of *Mazama* is 30–40% smaller and the p4 is 57–42% smaller than the fossil specimens; the premolars of *Pudu* are even smaller (HersHKovitz 1982).

*Blastocerus* mandible has a similar size to UAHMP 481, but their teeth are more hypsodont, their p3 and p4 are anteroposteriorly short, being the p3 the shortest; the p4 configuration is similar to that of a true molar, with a closed anterior and posterior valley (Guérin and Faure 2009). The anterolingual cristid of *Ozotoceros* p3 is reduced and its metaconid is short; *Blastocerus* and *Pudu* have an anterolingual cristid similar to that of *Odocoileus* (Webb 2000). In *Ozotoceros* the posterolingual conid of p4 is circular and simple, it may be faintly crested, but is not elongated and not connected to the posterior stylid (Webb 2000).

The p4 of *Mazama* is similar to that of *Cervus*, with a closed anterior valley, and oblique posterior and back valley (SOM Fig. 1) (HersHKovitz 1982).

The comparison of postcranial material of several American cervids also showed differences with the studied Pliocene specimens.

The postcranials of *O. virginianus* and *O. hemionus* are more slender and 25–20% smaller than the fossil postcranials from Amajac. Compared with the postcranials of *Odocoileus lucasi* from the Plio-Pleistocene of California and Idaho the studied specimens are around 32% smaller and stouter (Morejohn and Dailey 2004). The *Cervus canadensis* postcranials also are stout and about 50% larger than the Mexican fossil specimens.

The humerus of *Mazama* is smaller (30–50% depending on species), proportionally shorter and stouter than humeri UAHMP 484 and UAHMP 485 (HersHKovitz 1982; Guérin and Faure 2009).

Metacarpals of *Hippocamelus* are proportionally shorter and stouter than UAHMP 488, and those of *Mazama* also are proportionally shorter and around 40% smaller; *Pudu* has very short front and hindlimbs (HersHKovitz 1982; Webb 2000).

The above comparisons clearly show the morphological and size differences between the Pliocene cervid specimens from Amajac and *Odocoileus*, *Navahoceros*, *Cervus*, *Hippocamelus*, *Ozotoceros*, *Blastocerus*, *Pudu*, and *Mazama*. Thus, the cervid from Hidalgo cannot be assigned to any Rangiferini or to *Cervus*.

On the other hand, the studied specimens differ from Pliocene *Procapreolus* because in this genus the height of the mandible considerably decreases anteriorly; the teeth row length is around 24% smaller; the lower molars generally have a 'Paleomeryx' fold; the back valley of p3 remains open, and the posterior valley and the back valley of p4 also are open (Heintz 1970; Czyzewska 1968; Di Stefano and Petronio 2002).

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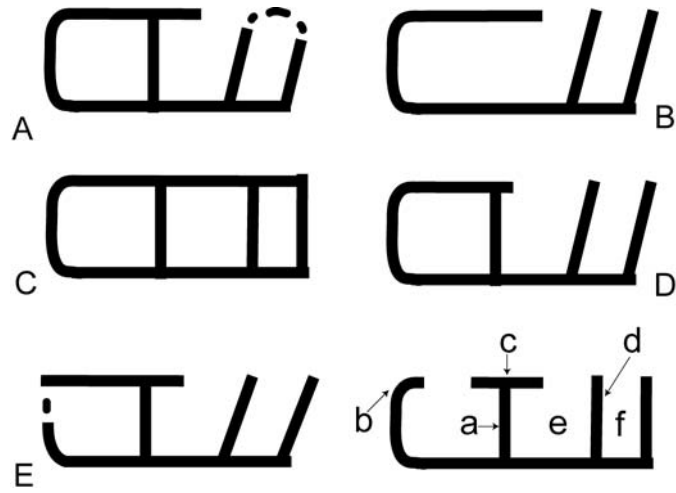


Figure 1. Diagrammatic p4 of selected New World cervids showing the connection and orientation of cristids. A. *Odocoileus*. B. *Capreolus*. C. *Navahoceros*. D. *Cervus*, *Mazama*. E. *Hippocamelus*. **Conids and cristids:** **a**, transverse cristid; **b**, anterior conid; **c**, mesolingual conid; **d**, posterolingual conid; **e**, posterior valley; **f**, back valley.