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RESEARCH ARTICLE

New hadrosaurid remains from the Late Cretaceous of Río Negro Province (Argentina, Late Cretaceous)

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Abstract
Purpose Although the hadrosaurid record is more abundant in the Northern Hemisphere than in the Southern Hemisphere, it is in Argentina that most remains have been discovered, specifically in Patagonia. This record is characterized by an extensive geographical distribution of sites, some of them with abundant remains, many of which have been assigned to a high taxonomic level as indeterminate hadrosauroids or hadrosaurids. Despite the abundance of indeterminate remains, three hadrosaurid species are recorded between Río Negro, La Pampa and Chubut provinces.
Method Here, new cranial and postcranial remains from indeterminate hadrosauroids, hadrosaurids and euhadrosaurians deposited in several museums Río Negro Province are presented and described here.
Results and Conclusions These new remains increase the distribution and abundance of these dinosaurs in Argentina and highlight the need for an in-depth revision of the history and evolution of this ornithopod clade in South America.

Keywords Hadrosauridae · Argentina · Late Cretaceous

Resumen
Propósito Aunque el registro de restos de hadrosáuridos es más abundante en el Hemisferio Norte que en el Hemisferio Sur, es en Argentina y especialmente en Patagonia en donde se ha encontrado la mayor cantidad de restos. Este registro se caracteriza por presentar una extensa distribución geográfica de los yacimientos, algunos de ellos con una gran cantidad de restos de los cuales muchos han sido asignados a un nivel taxonómico elevado, como hadrosauroideos o hadrosáuridos indeterminados. A pesar de la gran abundancia de material indeterminado, tres especies de Hadrosauridae han sido registradas entre las provincias de Río Negro, La Pampa y Chubut.
Método Aquí se presentan nuevos materiales craneales y postcraneales de hadrosauroideos, hadrosáuridos y euhadrosáuridos indeterminados encontrados en la provincia de Río Negro.
Resultado y Conclusión Estos nuevos restos aumentan la distribución y abundancia de estos dinosaurios en Argentina y ponen de manifiesto la necesidad de realizar una profunda revisión de la historia y evolución de este clado de ornitópodos de Argentina.

Palabras clave Hadrosauridae · Argentina · Cretácico Superior

1 Introduction

Hadrosaurids are the herbivorous dinosaurs with the greatest diversity from the Late Cretaceous (Eberth and Evans 2015). Their remains have been found mainly in the Northern Hemisphere (Horner et al. 2004). In the Southern Hemisphere, it is in Argentina that they are most highly represented (Coria and Cambiaso 2007). During the last decade, the diversity of Argentinian hadrosaurids has shown a significant increase, with the description of three taxa and one new species under study at present (Prieto-Márquez and Salinas 2010; Juárez Valieri et al. 2010; Coria et al. 2012; Corsolini 2014; Cruzado-Caballero and Coria 2016; Cruzado-Caballero and Powell 2017). As a consequence, much

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more is now known of the history of this clade in Argentina. Examples of this include the phylogenetic analyses undertaken by Prieto-Márquez and Salinas (2010) and Cruzado-Caballero and Powell (2017). The results of these analyses confirms the relationship between Argentinian and North American hadrosaurids, showing relationships with at least two tribes of North American hadrosaurines. Moreover, an increase in paleobiodiversity has been confirmed, as well as the geodispersal event from North America that took place no later than the late Campanian.

All the Argentinian taxa are from provinces with numerous sites with indeterminate remains (La Pampa, Río Negro and Chubut provinces, Fig. 1; Table 1). In this paper, new unpublished indeterminate hadrosaurid remains are studied with the aim of describing them and mapping the sites with indeterminate hadrosaurid remains in Argentina. These remains have been collected by several paleontologists from different localities in Río Negro Province since the middle of the last century and are deposited in three Patagonian museums in Río Negro Province: the Museo Jorge H. Gerhold (Ingeniero Jacobacci), the Museo Provincial Carlos Ameghino (Cipolletti) and the Museo Provincial "María Inés Kopp" (Valcheta).

Institutional abbreviations: MJG, Museo Jorge H. Gerhold (Ingeniero Jacobacci, Río Negro Province, Argentina); MPCA, Museo Provincial Carlos Ameghino (Cipolletti, Río Negro Province, Argentina); MRPV, Museo Regional Provincial de Valcheta (Valcheta, Río Negro Province, Argentina).

2 Hadrosaurid remains from localities in Río Negro Province

2.1 General Roca area

Dinosauria Owen 1842
Ornithischia Seeley 1887
Ornithopoda Marsh 1881
Hadrosauridae Cope 1869
Hadrosauridae indet.

Horizon and locality: late Campanian-early Maastrichtian, Allen Formation?, Puesto Machado site, south of General Roca city.
Material: a fragmentary left dentary (MPCA-Pv-25445), two cervical vertebrae (MPCA-Pv-25443 and 25444) and a caudal vertebra (MPCA-Pv-25442).

2.1.1 Dentary

A fragmentary left dentary of large size (anteroposterior length 107 mm; dorsoventral height 83 mm) that suggests that it may belong to a subadult or near-adult individual (MPCA-Pv-25445; Fig. 2a, b). This fragment corresponds to the most posterior part of the dentary. It preserves part of the Meckelian canal and the base of the coronoid process. The suprameckelian foramen is large and ellipsoid-shaped. The dental battery preserves 13 tooth positions, with fragmentary teeth in at least six of them. Due to the state of preservation, it is not possible to confirm how many replacement teeth the dental battery has per tooth position, but at least two replacement teeth can be observed at one tooth position.

2.1.2 Cervical vertebrae

Two large-sized centra of cervical vertebrae (MPCA-Pv-25443, Fig. 2d–g; and MPCA-Pv-25444; Fig. 2h–k) are indistinct from those of all other hadrosaurids. The centra are strongly opisthocoelous. They are particularly wide and short, with approximately the following proportions: width > height = length, and with heart-shaped anterior and posterior articular surfaces. MPCA-Pv-25444 is wider than long, and MPCA-Pv-25443 is longer than wide. The anterior articular surfaces are globular and the posterior surfaces are wider and cup-shaped. In MPCA-Pv-25443 the anterior surface is more broadly opisthocoelous than in MPCA-Pv-25444. The neural arches are fused and broken in both vertebrae. The parapophyses are located at mid-height on the depressed lateral sides. On the ventral side, there is a prominent longitudinal keel in MPCA-Pv-25443, which is absent in MPCA-Pv-25444. A few nutrient foramina of large size are observed on the lateral sides of both centra. The characters of a greater lateromedial width than anteroposterior length and the absence of a keel on the ventral side indicate a more anterior position in the vertebral series for MPCA-Pv-25444 than for MPCA-Pv-25443 (Horner et al. 2004).

2.1.3 Caudal vertebra

MPCA-Pv-25442 is a large-sized centrum. It is typically amphiplatyan, with subhexagonal articular surfaces and the following proportions height > width > length, as in all other hadrosaurids (Horner et al. 2004; Fig. 2i, j). The centrum preserves the base of transverse processes and large the haemapophyseal facets on the lateral and ventral side, respectively. The proportions, the presence of large haemapophyseal facets and the transverse processes indicate a position around the second or third vertebrae in lambeosaurines or the fourth or fifth vertebrae in all other hadrosaurids and the first 15 vertebrae in the tail (Horner et al. 2004).

2.2 Lamarque area

Hadrosauridae Cope, 1869
Hadrosauridae indet.

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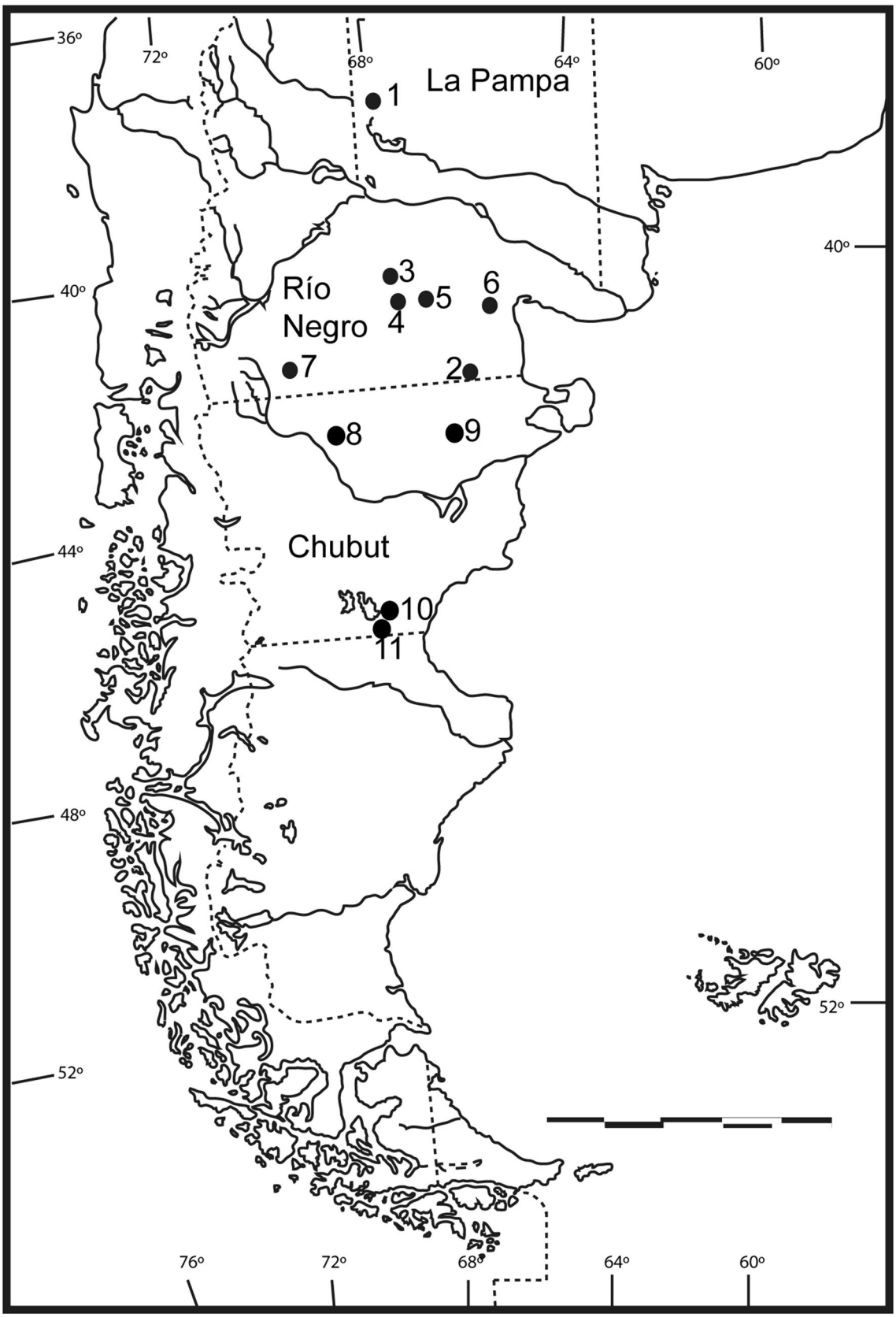

Fig. 1 Distribution map of the hadrosaurid record in Argentina. *Circle* hadrosaurid sites, see numbers in Table 1. *Scale* 500 km

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Table 1 Hadrosauridae record from Argentina

Number	Locality	Taxon	Age	Stratigraphic unit	References
La Pampa province					
1	Islas Malvinas	*Lapampasaurus cholinoi*	Late Campanian-early Maastrichtian	Allen Fm., Malargüe Group	González Riga and Casadío (2000) Juárez Valieri et al. (2010) Coria et al. (2012)
Río Negro province					
2	Arroyo Verde Puelén Departament	*Secernosaurus koerneri* (="*Kritosaurus australis*")	Late Campanian-early Maastrichtian	Los Alamitos Fm.	Bonaparte et al. (1984) Wagner (2001) Prieto-Márquez and Salinas (2010)
3	Salitral Moreno, General Roca Department	Hadrosauridae indet (="*Willinakaqe salitralensis*")	Late Campanian-early Maastrichtian	Allen Fm., Malargüe Group	Juárez Valieri et al (2010) Cruzado-Caballero and Coria (2016)
3	Salitral Moreno, General Roca Department	*Bonapartesaurus rionegrensis*	Late Campanian-early Maastrichtian	Allen Fm., Malargüe Group	Juárez Valieri et al (2010) Cruzado-Caballero and Powell (2017)
3	Puesto Machado site, General Roca Department	Hadrosauridae indet	Late Campanian-early Maastrichtian?	Allen Fm.?, Malargüe Group	This paper
4	Cerro Mesa, South of Villa Regina	Hadrosauridae indet	Late Campanian	Allen Fm., Malargüe Group	Corsolini (2014) Coria (2016)
5	Lamarque, Avellaneda Department	Hadrosauridae indet	Late Campanian-early Maastrichtian	Los Alamitos Fm.	Martinelli and Forasiep (2004)
6	Bajo Santa Rosa, Lamarque, Avellaneda Department	Hadrosauridae indet	Late Campanian-early Maastrichtian	Los Alamitos Fm.?	This paper
7	Cerro Mesa, Ingeniero Jacobacci, 5 de Mayo Department	Hadrosauridae indet	Campanian-early/medium Maastrichtian	Angostura Colorada/Coli Toro Fm.	Casamiquela (1964)
7	Bajo Colorado, Departamento Ingeniero Jacobacci, 5 de Mayo Department	Hadrosauridae indet	Campanian-early/medium Maastrichtian	Angostura Colorada/Coli Toro Fm.	Cruzado-Caballero (2015) This paper
7	Cona Niyeu, 9 de Julio Department	Hadrosauridae indet	Late Campanian-early Maastrichtian	Los Alamitos Fm.	Cruzado-Caballero (2015) This paper
Chubut province					
8	Between Paso del Sapo and Cerro Cóndor	Hadrosauridae indet	Campanian-Maastrichtian	Paso del Sapo Fm.	Apesteguía and Cambiaso (1999) Apesteguía et al. (2012)
9	La colonia	Hadrosauridae indet	Campanian-Maastrichtian	La Colonia Fm.	Hill et al. (2002) Gasparini et al. (2015)
10	Río Chico, east of Lake Colhué Huapi	*Secernosaurus koerneri*	Maastrichtian	Bajo Barreal Fm., Chubut Group	Brett-Surmann (1979) Bonaparte and Powell (1980)
11	South-east of Colhué Huapi Lake	Hadrosauridae indet	Campanian-Maastrichtian?	Bajo Barreal Fm., Upper Member	Luna et al. (2003)

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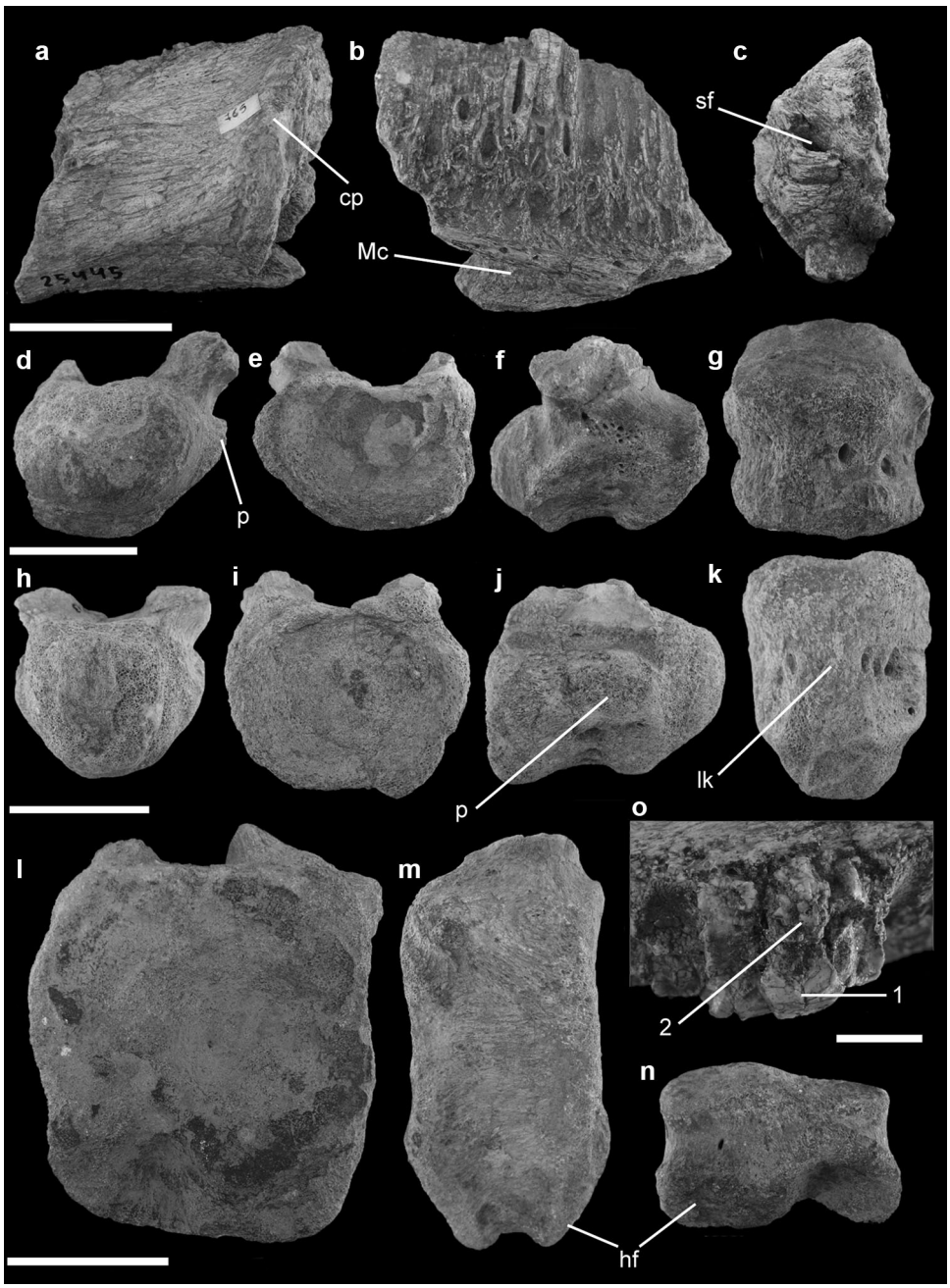

Fig. 2 Hadrosaurid remains from General Roca (Río Negro Province). **a–c**, **o** Partial dentary (MPCA-Pv-25445) in **a** medial, **b** lateral, **c** posterior and **o** dorsal views; **d–g** cervical vertebra (MPCA-Pv-25443) in **d** anterior, **e** posterior, **f** right lateral and **g** ventral views; **h–k** cervical vertebra (MPCA-Pv-25444) in **h** anterior, **i** posterior, **j** right lateral and **k** ventral views; **l–n** caudal vertebra (MPCA-Pv-25442) in **l** anterior, **m** right lateral and **n** ventral views. *cp* coronoid process, *hf* haemapophyseal faet, *lk* longitudinal keel, *Mc* Meckelian canal, *p* parapophysis, *sf* supramecklelian foramen. *Scale bar* **a–k** = 5 cm and *scale bar* **l** = 2 cm

Horizon and locality: late Campanian-early Maastrichtian, Los Alamitos Formation?, Bajo Santa Rosa site, Lamarque town.
Material: seven fragmentary dentaries, MRPV 431/P to 437/P.

2.2.1 Dentaries

MRPV 431/P to 437/P are seven fragmentary dentaries; they are small size and highly eroded (Fig. 3a–g). They have the characteristic parallel tooth positions of Hadrosauridae sensu Horner et al. (2004). The lateral surface of the fragments is smooth and prominently convex. They do not preserve any teeth; the shape of the septa that separate the dental alveoli is thin and sheet-like; and the dental alveoli are narrow, upright and parallel to each other.

2.3 Departamento 9 de Julio

Hadrosauridae Cope, 1869
Hadrosauridae indet.

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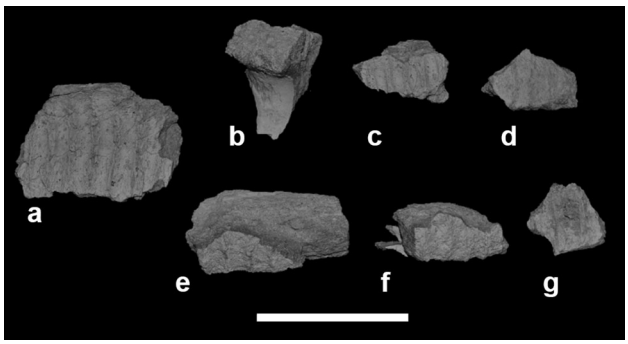

Fig. 3 Hadrosaurid remains from Lamarque (Río Negro). **a**–**g** Seven fragments of the dentaries MRPV 431/P to 437/P respectively in medial view. *Scale bar* 5 cm

Material: a cervical vertebra, MJHG.Pa26/9/14-61; a distal fragment of a left humerus MJHG.Pa26/9/14-59; and an almost complete humerus MJHG.Pa26/9/60.
Horizon and locality: late Campanian-early Maastrichtian, Los Alamitos Formation, Cona Niyeu area near the Departamento 9 de Julio (Río Negro Province, Argentina).

2.3.1 Cervical vertebra

MJHG.Pa26/9/14-61 is a large-sized centrum (Fig. 4a, b); it is indistinguishable from those of all other hadrosaurids: it is short and strongly opisthocoelous (Horner et al. 2004). The anterior articular surface is globular; the posterior surface is wider and cup-shaped, and a few nutrient foramina are observed on the lateral sides. There is no keel on the ventral side, probably due to its anterior position in the vertebral series (Horner et al. 2004). The junction with the neural arch is broken and was apparently fused.

2.3.2 Humeri

MJHG.Pa26/9/14-60 is an almost complete left humerus (Fig. 4d). Part of the proximal end, the anterior border of the deltopectoral crest, and the distal end are broken. It is large (dorsoventral length 284 mm; maximum anteroposterior width 101.1 mm) and robust, and it probably belongs to an adult individual. The diaphysis is strongly curved posteriorly, and the posterior border is markedly concave. The cross-section of the diaphysis is square. The width of the deltopectoral crest is almost twice the diameter of the diaphysis. This feature (a deltopectoral crest that is well-developed anteroposteriorly and extends more than half-way down the shaft) is characteristic of euhadrosaurian hadrosaurids (Hadrosaurinae + Lambeosaurinae; Horner et al. 2004). The bicipital groove on the deltopectoral crest is wide and smooth.

MJHG.Pa26/9/14-59 is a distal fragment of a left humerus with a similar size to MJHG.Pa26/9/14-60 (Fig. 4c). The fragment preserves both condyles and a small portion of the diaphysis. It has a quadrangular cross-section. The ulnar condyle is slightly more developed than the radial condyle, and the intercondylar groove is wider on the cranial side than on the caudal side of the humerus.

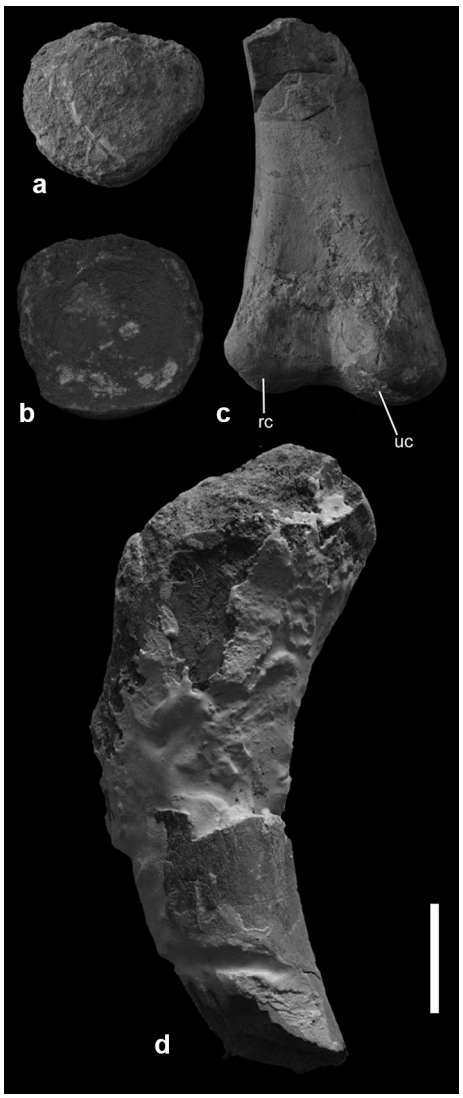

Fig. 4 Hadrosaurid remains from Departamento 9 de Julio (Ingeniero Jacobacci, Río Negro Province). **a**, **b** Cervical vertebra (MJHG.Pa26/9/14-61) in **a** anterior and **b** posterior views; **c** a distal fragment of left humerus (MJHG.Pa26/9/14-59) in posterior view; and a left humerus (MJHG.Pa26/9/14-60) in posterior view. *rc* radial condyle, *uc* ulnar condyle. *Scale bar* 5 cm

2.4 Ingeniero jacobacci

Hadrosauridae Cope, 1869
Hadrosauridae indet.

Material: MJHG.Pa26/9/14-53, a cervical vertebra; MJHG.Pa26/9/14-10, 23, 51, three dorsal vertebrae; MJHG.Pa26/9/14-12, a sacral? vertebra; MJHG.Pa26/9/14-

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13 to 22, 24 to 26, 28 to 29, 35 to 38, 40 to 46, 48 to 49, twenty-eight caudal vertebrae; MJHG.Pa26/9/14-8, 9, two scapulae; MJHG.Pa26/9/14-53, an ulna; MJHG.Pa26/9/14-7, 47, two metacarpals; MJHG.Pa26/9/14-4, 5, two ilia; MJHG.Pa26/9/14-3, 6, two ischia; MJHG.Pa26/9/14-1, a pubis; MJHG.Pa26/9/14-57, a femur; MJHG.Pa26/9/14-55, a metatarsal; and MJHG.Pa26/9/14-2, 56, two pedal phalanges.

Horizon and locality: early Campanian-middle Maastrichtian, Angostura Colorada/Coli Toro Formations. The Bajo Colorado area is near the town of Ingeniero Jacobacci (Río Negro Province, Argentina).

2.4.1 *Cervical vertebra*

This element (MJHG.Pa26/9/14-53) only preserves a very small and eroded centrum that shows the typical characteristic of hadrosaurids, being short and strongly opisthocoelous (Horner et al. 2004; Fig. 5a–c). The anterior articular surface is globular, and the posterior surface is wider and cup-shaped. Due to the erosion, the centrum has not preserved the ventral longitudinal keel, and it is not possible to see the suture or break with the neural arch. Given the small size of the centrum, it is likely to belong to a juvenile individual, although this cannot be stated definitively without an osteohistological analysis (Irmis 2007).

2.4.2 *Dorsal vertebrae*

There are two dorsal vertebral centra (MJHG.Pa26/9/14-10 and 23; Fig. 5d, e) and one neural arch (MJHG.Pa26/9/14-51). The centra are amphiplatyan and have the typical shape of hadrosaurids, with heart-shaped cranial and caudal articular surfaces (Horner et al. 2004). In ventral view, there is a strong ridge running along the side, joining the two articular surfaces. The lateral sides are concave and pierced by several irregularly distributed nutrient foramina. MJHG.Pa26/9/14-10 is anteroposteriorly longer than MJHG.Pa26/9/14-23, indicating a possibly more anterior position in the dorsal series. In dorsal view, both centra show the suture with the neural arch, indicating that this element belongs to a juvenile individual (Irmis 2007).

MJHG.Pa26/9/14-51 is a dorsal neural arch, which displays some typical characters of Hadrosauridae, such as a lateromedially-narrow neural spine and laterally inclined articular surfaces of the postzygapophyses (Horner et al. 2004). The neural arch seems to show a suture surface with the centrum, indicating that it belongs to a juvenile individual (Irmis 2007). The postzygapophyses are big, ellipsoidal in shape, and there is a deep sulcus separating them. The sulcus widens distally.

2.4.3 *Sacral vertebra*

MJHG.Pa26/9/14-12 is a possible sacral centrum (Fig. 5f, g). The articular surfaces are elliptical in outline, wider than high and concave, as in all hadrosaurids (Horner et al. 2004). The lateral sides are concave and pierced by several small nutrient foramina that are distributed lineally at the mid-width of the centrum. Due to the slight erosion of the centrum on the dorsal side, it is not possible to know whether there is a suture in the surface of the junction with the neural arch. Given its extremely small size, it is likely that it belongs to a juvenile individual, although this cannot be asserted definitively without an osteohistological analysis (Irmis 2007).

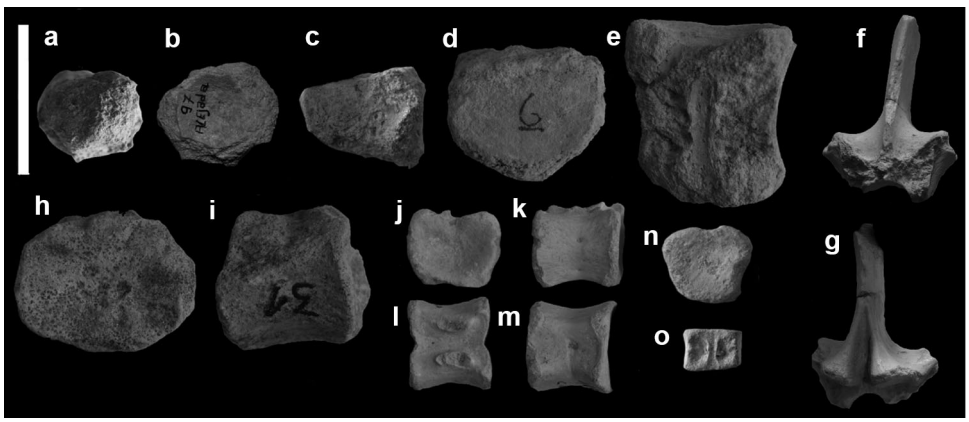

Fig. 5 Hadrosaurid vertebra remains from Bajo Colorado (Ingeniero Jacobacci, Río Negro Province). **a**–**c** Cervical vertebra (MJHG.Pa26/9/14-53) in anterior (**a**), posterior (**b**) and left lateral (**c**) views; **d**, **e** dorsal vertebra (MJHG.Pa26/9/14-10) in anterior (**d**) and dorsal (**e**) views; **f**, **g** dorsal neural arch (MJHG.Pa26/9/14-51) in anterior (**f**) and posterior (**g**) views; **h**, **i** sacral vertebra (MJHG.Pa26/9/14-12) in anterior (**h**) and right lateral (**i**) views; **j**–**m** caudal vertebra (MJHG.Pa26/9/14-26) in anterior (**j**), right lateral (**k**), dorsal (**l**) and ventral (**m**) views; and **n**, **o** caudal vertebra (MJHG.Pa26/9/14-35) in anterior (**n**) and dorsal (**o**) views. *hf* haemapophyseal facet. *Scale bar* 5 cm

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2.4.4 Caudal vertebrae

Twenty-eight centra of caudal vertebrae have been identified (MJHG.Pa26/9/14-13 to 22, 24 to 26, 28 to 29, 35 to 38, 40 to 46 and 48 to 49; Fig. 5h–m). They are all small and belong to the medial and posterior sections of the caudal series. Some of the specimens show the suture surface with the neural arch and others show fusion with the base of the neural arch. The centra are typically amphiplatyan, with quadrangular to hexagonal articular surfaces that are slightly eroded, all of them indistinguishable from those of all other hadrosaurids (Horner et al. 2004). Between the articular surfaces, the lateral sides of the centra are slightly depressed and pierced by irregularly-distributed nutrient foramina. The ventral sides of the centra are slightly concave. Almost all of them present haemapophyseal facets on the ventral side.

2.4.5 Scapula

Two proximal fragments of scapulae have been identified (MJHG.Pa26/9/14-8 and 9; Fig. 6a, b). Both are small in size: MJHG.Pa26/9/14-8 (anteroposterior length 74.64 mm, dorsoventral width 39 mm) is smaller than MJHG.Pa26/9/14-9 (anteroposterior length 91.56 mm, dorsoventral width 61.73 mm). On both bones there is a stout, dorsoventrally-directed deltoid ridge. The anterior dorsal border is straight and concave under the anterior ventral border in both scapulae. The most proximal part of MJHG.Pa26/9/14-9 is broken. MJHG.Pa26/9/14-8 has a markedly convex coracoid facet and a straight acromial process. The latter does not pass beyond the middle of the posteroventral process, which is well developed, triangular and ventrally directed. The glenoid of MJHG.Pa26/9/14-8 is large and markedly concave. In medial view, there is a depressed zone in the area of the acromial process of MJHG.Pa26/9/14-8.

2.4.6 Ulna

MJHG.Pa26/9/14-53 is an almost complete left ulna of small size (333 mm length). It is relatively robust, with a very well-developed olecranon process (Fig. 6c). The proximal end is eroded and the medial process is not preserved. It curves gently in an S-shape, as occurs in several hadrosaurines and lambeosaurines (see references in Godefroit et al. 2004, 2012; Cuthbertson and Holmes 2010; Prieto-Márquez and Serrano Brañas 2012). The lateral process is low and thin. The articular facet for the proximal part of the radius is particularly enlarged and has longitudinal striations indicating strong ligamentous attachment with the radius. The ulna progressively tapers distally. Its distal end is somewhat eroded, rounded, laterally compressed, and triangular in cross-section.

2.4.7 Metacarpals

Two small metacarpals from digit II? have been identified (MJHG.Pa26/9/14-7 and 47; Fig. 6n, o; length 150.62 and 110.73 mm respectively). They are elongated and pencil-shaped, with only slightly expanded and rounded articular ends typical of Hadrosauridae (Horner et al. 2004). The lateral sides are regularly convex, whereas the medial sides are slightly concave or almost straight along their entire length, and bear longitudinal striations for ligamentous attachment with metacarpal III.

2.4.8 Ilia

MJHG.Pa26/9/14-4 and 5 are two incomplete, small preacetabular processes of right ilia (Fig. 6d, e; anteroposterior length 164 and 95.89 mm respectively). They are dorsoventrally wide, mediolaterally narrow, and directed slightly ventrally.

2.4.9 Ischia

MJHG.Pa26/9/14-3 and 6 are two almost-complete, small left ischia (Fig. 6g, h; length 167 and 255 mm respectively), which are lack their distal ends. MJHG.Pa26/9/14-6 is more complete than MJHG.Pa26/9/14-3. Both preserve an anterior part that is elongated and mediolaterally flat. These parts are almost complete, although they have not preserved the pubic and iliac processes, and part of the shaft. The ischial shaft of MJHG.Pa26/9/14-6 is straight and robust.

2.4.10 Pubis

MJHG.Pa26/9/14-1 is a small, fragmentary right pubis (Fig. 6f) that has preserved part of the prepubic process, the iliac peduncle and the proximal part of the pubic shaft. The prepubic neck is strongly constricted and is long, with the dorsal border nearly straight (as in hadrosaurine taxa) and the ventral border strongly concave in lateral view (Gates et al. 2011). The iliac peduncle is long and robust; its anterior border is slightly anteriorly directed; and it has a triangular cross-section. Its articular face projects posterodorsally. The anterior side of the iliac peduncle is slightly concave, as is the preserved part of the posterior side.

2.4.11 Femur

MJHG.Pa26/9/14-57 is a right femur (Fig. 6p, q). It is almost complete, although its proximal and distal ends are broken and eroded. It is short (256 mm in length); the shaft is straight and mediolaterally narrow, with a rectangular cross-section. The proximal end has preserved the base of

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Fig. 6 Hadrosaurid remains from Bajo Colorado (Ingeniero Jacobacci, Río Negro Province). **a** Right scapula (MJHG.Pa26/9/14-9) in lateral view **b**, right scapula (MJHG.Pa26/9/14-8) in lateral view; **c** left ulna (MJHG.Pa26/9/14-53) in lateral view; **d** right ilium (MJHG.Pa26/9/14-4) in lateral view; **e** right ilium (MJHG.Pa26/9/14-5) in lateral view; **f** left pubis (MJHG.Pa26/9/14-1) in lateral view; **g** left ischium (MJHG.Pa26/9/14-6) in lateral view; **h** left ischium(MJHG.Pa26/9/14-3) in medial view; **i** right humerus (MJHG.Pa26/9/14-32) in lateral view; **j** left humerus (MJHG.Pa26/9/14-34) in lateral view; **k** right humerus (MJHG.Pa26/9/14-31) in lateral view; **m** left humerus (MJHG.Pa26/9/14-339,) in lateral view; **n** metacarpal (MJHG.Pa26/9/14-7) in anterior view; **o** metacarpal (MJHG.Pa26/9/14-47); **p**, **q** right femur (MJHG.Pa26/9/14-57) in lateral (**p**) and medial (**q**) views; **r** metatarsal (MJHG.Pa26/9/14-55) in dorsal view; **s** pedal phalanx (MJHG.Pa26/9/14-2) in dorsal view; **t** pedal phalanx (MJHG.Pa26/9/14-56) in dorsal view. *dr* deltoid ridge, *g* glenoid, *4t* trochanter. *Scale bars* 5 cm

the femoral head and the greater trochanter, which are separated by a wide groove.

The 4th trochanter and the medial condyle are eroded. The lateral condyle is expanded anteroposteriorly, its proximodistal expansion is broken, and it is narrow lateromedially.

2.4.12 Metatarsal

MJHG.Pa26/9/14-55 is a distal fragment of metatarsal III (Fig. 6r; length 59.97 mm). The distal end is slightly expanded, and its articular surface is rectangular with a saddle shape. The plantodorsal intercondylar groove is poorly developed and divides the distal articular surface into two subequal parts. The medial side of the distal articular end forms a cup-like depression.

2.4.13 Pedal phalanges

Both MJHG.Pa26/9/14-2 and 56 are first phalanges of digit IV (Fig. 6s, t; length 63.8 and 31.39 mm respectively). They are longer than wide, as in other hadrosaurids (Horner

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et al. 2004). Both phalanges are small, although MJHG.Pa26/9/14-2 is larger. Their medial side is elevated and slightly concave; their lateral sides are shallower and vertical.

Material: MJHG.Pa26/9/14-31 to 34 and 39, five humeri.

Hadrosauridae Cope, 1869

Euhadrosauria Weishampel, Norman and Grigorescu, 1993

Euhadrosauria indet

2.4.14 Humeri

Five humeri of different size have been identified (MJHG.Pa26/9/14-31 to 34 and 39; Fig. 6i–m). Of these, the right humerus MJHG.Pa26/9/14-31 and the left humerus MJHG.Pa26/9/14-33, are of similar size (dorsoventral length without plaster 176 mm and maximum anteroposterior width 54.22 mm; dorsoventral length 241 mm and maximum anteroposterior width 51.55 mm respectively), which suggest that they could belong to the same individual or to individuals of the same ontogenetic stage (Fig. 6k, l). The same applies to MJHG.Pa26/9/14-32, a right humerus, and MJHG.Pa26/9/14-34, a left humerus (Fig. 6i, j; dorsoventral length without plaster 224 mm and maximum anteroposterior width 62.3 mm; dorsoventral length without plaster 265 mm and maximum anteroposterior width 62.67 mm respectively). These four humeri are almost complete. MJHG.Pa26/9/14-39 only preserves part of the proximal end with the humeral head (Fig. 6m). The preserved diaphyses of all the humeri are strongly curved posteriorly, with the posterior borders markedly concave. The cross-section of the diaphysis is quadrangular and the bicipital groove is wide in all the humeri described here. The deltopectoral crest is more developed than in basal hadrosaurids such as *Telmatosaurus* (Weishampel et al. 1993). The length of the deltopectoral crest is almost half the length of the diaphysis, and the width is almost double or slightly greater than the diameter of the diaphysis in all the humeri. A deltopectoral crest that is well developed anteroposteriorly and extend more than halfway down the shaft is characteristic of euhadrosaurian hadrosaurids (Horner et al. 2004; Brett-Surman and Wagner 2007).

3 Discussion

Río Negro Province yields the richest localities with hadrosaurid remains, with at least nine sites distributed throughout the province (Fig. 1; Table 1). Some of the sites studied contain poorly preserved remains, such as the fragmentary dentaries of Bajo de Santa Rosa (Lamarque), whereas others are richer, such as for example the site in the Bajo Colorado area (Ingeniero Jacobacci) or Salitral Moreno site (General Roca).

The remains studied from the Puesto Machado site (south of General Roca city) belong to an adult individual of large size. There is a chance that these vertebrae pertain to an individual from *Bonapartesaurus rionegrensis* recently described from the site of Salitral Moreno, but as the cervical vertebra have not been preserved and the caudal vertebral centra of *Bonapartesaurus rionegrensis* does not have autapomorphic characters, it is only possible to assign them to an indeterminate hadrosaurid.

The remains from the Lamarque area are poorly preserved and likely to belong to juvenile individuals, but this cannot be definitively established without an osteohistological analysis (Irmis 2007). The fact that they have no teeth preserved in situ prevents a more inclusive assignment within Hadrosauridae.

The remains from the Cona Niyeu area (Departamento 9 de Julio), though also scarce, are better preserved. Their large size indicates that they probably belong to an adult individual. The humeri, though fragmentary, have a more developed deltopectoral crest than basal hadrosaurids. However, given the incomplete state of the crest and the absence of diagnostic characters, the remains are assigned to an indeterminate hadrosaurid.

Finally, the remains from the area of Ingeniero Jacobacci are the most numerous of all. They were collected from the surface of terrestrial sediments from the Angostura Colorada Formation and marine/transitional sediments. They probably all belong to juvenile individuals, but this cannot be affirmed definitively without an osteohistological analysis (Irmis 2007). All of them exhibit a good state of preservation. Unfortunately, the probable juvenile stage and the scarcity of diagnostic characters in the postcranial elements of hadrosaurids, something typical of the clade, have made it impossible to classify the remains beyond the family level. Nonetheless, on the basis of the development of the deltopectoral crest it has at least been possible to assign the humeri to an indeterminate euhadrosaurid.

4 Conclusion

Within the Argentinian clade of hadrosaurids the paleobiodiversity of taxa fluctuates continuously with the emergence of new studies. One example of this is the taxon "*Kritosaurus*" *australis*, which was proposed as a synonym of *Secernosaurus koerneri* by Prieto-Márquez and Salinas (2010); later Coria (2016) proposed that the Argentinian "*Kritosaurus*" is not related to the North

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American *Kritosaurus* or to *Secernosaurus* and thus requires a new genus combination. Another example is *Willinakaqe salitranensis*, described by Juárez Valieri et al. (2010), which has recently been invalidated by Cruzado-Caballero and Coria (2016). Finally, there is the addition of two new genera and species, one hadrosaurine described by Cruzado-Caballero and Powell (2017) and a hadrosaurid discovered by Corsolini (2014) and currently under study (Corsolini et al. in prep.). If we add the new information obtained from the indeterminate remains of Río Negro Province, it will be possible to provide a framework for the broader distribution and abundance of these dinosaurs throughout the Argentinian Patagonia.

In conclusion, the hadrosaurid record from Argentina has seen numerous changes in the validity of its taxa and an increase in the number of discoveries that have provided new osteological data. An in-depth revision of the history and evolution of this clade in Argentina, its connection with the rest of Gondwana, and its relationships with non-South American hadrosaurid taxa will shed light on one of the most interesting chapters of the evolution of dinosaurs in this continent.

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