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ARTICLE



An unexpected large Crested Tinamou (*Eudromia*, Tinamidae, Aves) near to Last Glacial Maximum (MIS 2, late Pleistocene) of the Argentine Pampas

Marcos Cenizo^{a,b}, Jorge Noriega^c, Juan Diederle^c, Esteban Soibelzon^d, Leopoldo Soibelzon^d, Sergio Rodriguez^e and Elisa Beilinson^f

^aDivisión Paleontología, Museo de Historia Natural de La Pampa, Santa Rosa, Argentina; ^bFundación de Historia Natural “Félix de Azara”, Departamento de Ciencias Naturales y Antropología, CEBBAD – Universidad Maimónides, Buenos Aires, Argentina; ^cCICYTTP – CONICET – GOB. ER – UADER, Materi y España, Diamante, Argentina; ^dCONICET – División Paleontología Vertebrados, Museo de La Plata, La Plata, Argentina; ^eFacultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina; ^fCONICET – Centro de Investigaciones Geológicas, La Plata, Argentina

ABSTRACT

A large nearly complete specimen of a Crested Tinamou (*Eudromia*, Tinamidae, Aves) is described. It was collected at ‘Nicolás Vignogna III’ Quarry in Marcos Paz County (Buenos Aires Province, Argentina), coming from near the top of a succession assigned to the Lujanian Stage. Radiocarbon dates constrain the age of the fossil bearing lithosome to the late Pleistocene – early Holocene, including the complete geochronological interval assigned to MIS 2. The new fossil specimen of *Eudromia* from Marcos Paz exceeds the size range of living species of the genus; but it is osteologically almost indistinguishable from them. Based on the lack of conclusive morphological and metrical differences with modern *Eudromia* spp., its specific status is not definitely ascertained in this contribution, being considered as a probable large morph of *E. elegans*. Crested tinamous are inhabitants of open and xeric environments with warm temperate to cold temperate climatic conditions. The fossil location is more than 250 km east of the eastern distributional limit of the nearest extant species. This geographical outlier could be tentatively associated with the expansion of arid or semiarid palaeoenvironments typical of the Central or Patagonian domains over the temperate Pampean grasslands during the MIS 2 times.

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Introduction

Tinamous are medium-sized ground birds with limited flight capabilities, endemic to the Neotropics. Based on their habitat preferences, Miranda-Ribeiro (1938) proposed the subfamilies Tinaminae for the forest-dwelling tinamids and Nothurinae (= Rhyngotinae, see Cabot 1992) for the steppe species. Recent molecular, morphological and data-combined phylogenies support the monophyly of these two main tinamid lineages (Porzecanski 2003; Bertelli and Porzecanski 2004; Bertelli et al. 2014; Bertelli 2017). The Nothurinae includes the two modern species of the genus *Eudromia*: the Elegant Crested Tinamou *E. elegans* Geoffroy Saint-Hilaire 1832 and the Quebracho Crested Tinamou *E. formosa* (Lillo 1905).

The oldest fossil record of *Eudromia* corresponds to an indeterminate species from the late Miocene of La Pampa Province (Cenizo et al. 2012), being *E. olsoni* (Tambussi and Tonni 1985) from the late Miocene – early Pliocene of Buenos Aires Province, the only known paleospecies. Other fragmentary specimens from the late Pliocene of the Pampean region were assigned directly or tentatively to the later extinct species (Tonni 1977; Tambussi 1987; Tambussi and Noriega 1996) without a formal justification (see Cenizo et al. 2012). Several Pleistocene and Holocene records from the Pampean and Patagonian regions have been referred to *Eudromia* sp. (Rey et al. 2005; Cenizo et al. 2015) or specifically to the extant *E. elegans* (Tonni 1983; Tambussi and Tonni 1985;

Cuello 1988; Tambussi and Noriega 1996; Tambussi and Acosta Hospitaleche 2001; Avila and Ceruti 2013). However, so far, an allocation to specific level of these specimens is not possible because the two living *Eudromia* form a superspecies (Short 1975), and are indistinguishable in their postcranial elements; even more, this fact can also be applied to at least its youngest fossil representatives.

The unexpected finding of a large nearly complete late Pleistocene – early Holocene specimen of Crested Tinamou in the north-eastern of Buenos Aires Province, outside the current geographic distribution of its living relatives, could constitute a significant palaeoclimatic signal around Marine Isotope Stage (MIS) 2 (ca. 10–30 ka BP). Moreover, in order to assess the specific status of the specimen herein studied, we performed a detailed comparative analysis and discussed considerations concerning size between living forms of the genus. (2)

Materials and methods

Comparisons were undertaken with specimens of the following extant species, which are deposited in the Museo Argentino de Ciencias Naturales (Buenos Aires, Argentina), Museo de La Plata (La Plata, Argentina), and authors’ collection (MC) housed in the Museo de Historia Natural de La Pampa (Santa Rosa, Argentina): *Crypturellus parvirostris* (1),

C. tataupa (3), *C. undulatus* (1), *Eudromia elegans* (26), *E. formosa* (1), *Nothoprocta cinerascens* (20), *N. ornata* (3), *N. pentlandii* (5), *Nothura boraquira* (1), *N. darwinii* (12), *N. maculosa* (22), *Rhynchotus rufescens* (17), *Tinamotis ingoufi* (3), *T. pentlandii* (1), *Tinamus solitarius* (1). The anatomy of the remaining living genera (*Nothocercus*, *Taoniscus*) was evaluated using information, drawings and photographs taken from Bertelli (2002), Bertelli and Chiappe (2005), and Bertelli et al. (2014).

Osteological terminology follows Baumel and Witmer (1993). Measurements (in mm) were taken with a digital Vernier caliper to the nearest 0.01 mm and are expressed as follows: min–max, mean (n).

Measurement abbreviations: D-prox, depth of distal end; L-post, length from the caudal margin of the foramen acetabuli to the caudal end of the processus terminalis ischii; L-pre, length from the cranial margin of the foramen acetabuli to the cranial end of the preacetabularis ilii wing; TL, total length; W-dist, width of distal end; W-fa, width of facies articularis sternalis; W-prox, width of proximal end; W-shaft, width of shaft.

Radiocarbon dates were taken from Soibelzon et al. (2012) and Gasparini et al. (2016).

Geological framework and age

The fossil remains were collected at the ‘Nicolás Vignogna III’ Quarry (34°54′51″ S – 58°42′28″ W, Marcos Paz County, Buenos Aires Province, Argentina; Figure 1 (A)).

The identified local facies associations (FA) show the temporal and spatial evolution of the late Pleistocene–Holocene depositional systems of the SW Río de la Plata margin, from an inner estuarine environment affected by sporadic storms surges to a fluvial environment that evolved into an eolian one.

In the studied section (Figure 1 (B)) the lower levels correspond to cross-bedded to massive fine sands that were interpreted as fluvial deposits (FA 4). Some *Heleobia parchappii* shells found in equivalent levels of the same quarry were dated by Gasparini et al. (2016) in $29,070 \pm 1,420$ and $32,580 \pm 1,520$ RCYBP. The rest of the succession

corresponds to brown silty muds and fine sands with thin lamination, carbonate intraclasts and tabular geometry interpreted as loess and loess-like deposits (FA 5). Internally, two different lithosomes can be identified here. The lower one is rich in carbonate intraclasts (presumably they correspond to a calcic paleosol developed in the top of the underlying FA4). The fossil specimen was found near the top of this deposit (Figure 1 (B)). The upper lithosome is massive in appearance, probably due to the intense bioturbation generated by the development of the modern soil profile. Some *Biomphalaria* sp. shells recovered from this upper lithosome were dated by Soibelzon et al. (2012) in $8,480 \pm 130$ RCYBP. The two mentioned radiocarbon ages (Figure 1 (B)) allow to constrain the age of the studied avian remains to the late Pleistocene – early Holocene, including the complete geochronological interval assigned to MIS 2.

Systematic paleontology

Aves Linnaeus, 1758

Tinamiformes Huxley, 1872

Tinamidae Gray, 1840

Eudromia Geoffroy Saint-Hilaire, 1832

Eudromia sp.

Referred material. The specimen MPLK-03 (Figure 2) is housed at the Museo de Ciencias Naturales ‘Lucas Kraglievich’ (Marcos Paz County, Buenos Aires Province, Argentina) and includes elements of the forelimb (humerus, ulnae, radi, carpometacarpi, and phalanges) and hindlimb (femora, tibiotarsi, fibulae, right tarsometatarsus, and phalanges), girdles (scapulae, coracoids, fragmentary sternum and pelvis), and a partial vertebral column including some cervical vertebrae and notarium.

Description and comparisons. Between tinamous, the specimen MPLK-03 is referred to *Eudromia* by the presence of the following autapomorphic characters (modified from Bertelli et al. 2014): (1) coracoid with overhanging tuberculum brachiale, (2) tarsometatarsus with a broad hypotarsal sulcus for m. flexor digitorum longus, and (3) absence of a sharp medial ridge at the cotyla medialis of the tarsometatarsus.

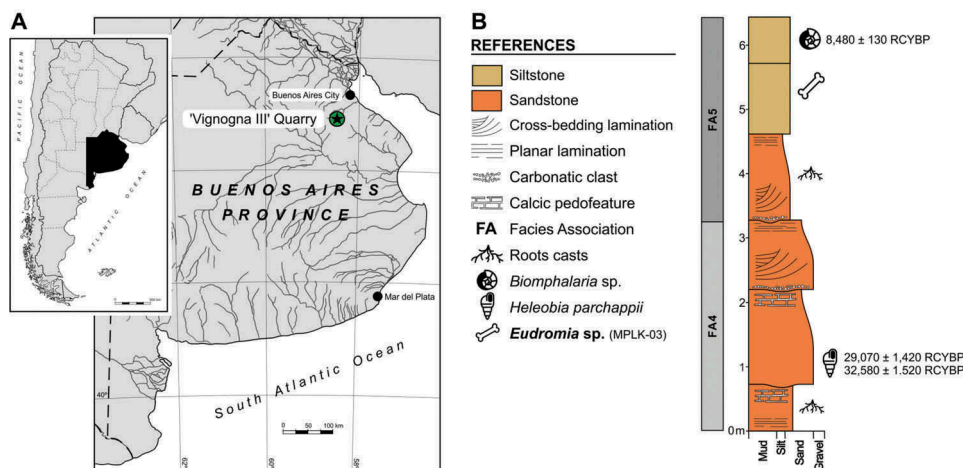


Figure 1. Geographical location (A) of ‘Nicolás Vignogna III’ Quarry (Marcos Paz County, Buenos Aires Province, Argentina) and stratigraphic profile at the section where MPLK-03 was collected (B) showing the local facies associations identified and available radiocarbon ages.



Figure 2. MPLK-03 specimen here assigned to *Eudromia* sp. collected in late Pleistocene – early Holocene outcrops of the ‘Nicolás Vignona III’ Quarry (Marcos Paz County, Buenos Aires Province, Argentina). A. Recovered bones (in blue). B. Left humerus. C. Right ulna. D. Left radius. E. Left carpometacarpus. F. Left phalanx proximalis digiti majoris. G. Left phalanx digiti minoris. H. Left coracoid. I. Left scapula. J. Sternum. K. Left femur. L. Left fibula. M. Left tibiotarsus. N. Right tarsometatarsus. O. Vertebrae cervicales. P. Notarium and costae. Q. Pelvis. All figures are to the same scale (scale bar = 10 mm) except A.

Additionally, the specimen MPLK-03 shares with extant *Eudromia* spp. and differs from other similar-sized tinamous (*Tinamotis*, *Rhynchotus*, and *Tinamus*) in the following combination of characters (Bertelli et al. 2014):

Sternum: (1) short cranial projection of the spina interna rostra (markedly elongate in *Tinamus*). **Coracoid:** (2) groove for origin of ligamentum acroracohumerale confluent with facies articularis clavicularis (separated in *Rhynchotus*); (3) processus acroracoides exceeding the cranial projection of the facies articularis humeralis (absent in *Rhynchotus* and *Tinamus*); (4) proximal margin of cotyla scapularis perforated with large foramina (absent foramina in *Tinamus*); (5) medial edge of the base of processus procoracoides with a distinctly projected crest (absent in *Tinamus*); (6) dorsal view, processus lateralis distinctly longer than sternal facet, three-pointed sternal end (shorter or similar than sternal facet in *Tinamus*); (7) in the dorsal surface of distal end not pneumatized impression for the m. sternocoracoidei (sometimes few openings are observed in *Rhynchotus*). **Humerus:** (8) in caudal view, crista bicipitalis distinctly squared off with a hooked-shaped extension (more rounded in *Tinamus*); (9) absent foramen pneumaticum surrounded by osseous ring or muscular scar (generally present in *Rhynchotus*); (10) main axis of the ventral condyle longer to that of dorsal condyle (shorter in *Tinamotis*); (11) processus supracondylaris dorsalis slightly developed as a tubercle (well developed in *Tinamus* and *Rhynchotus*); (12) processus supracondylaris ventralis positioned on ventral surface or cranioventral margin (more cranially located in *Tinamotis*); (13) distally short processus flexorius (projected beyond the ventral condyle in *Rhynchotus*); (14) ulna distinctly longer than humerus (about the same length in *Rhynchotus*). **Radius:** (15) distal end with curved aspect, one side more projected than the other (distal end wider with both sides expanded in *Tinamotis*). **Carpometacarpus:** (16) caudal rim of the trochlea carpalis with deep notch their ventral portion, shallow fossa infratrochlearis (ventral portion of the caudal rim weakly notched or notch absent, deep and well-defined infratrochlear pit in *Rhynchotus*). **Pelvis:** (17) most vertebrae with compressed centrum and relatively narrow processes fused to the lamina (flat centrum with wide processus costales not completely fused to the lamina in *Tinamus*); (18) dorsal surface of postacetabular area not depressed (distinctly depressed in *Rhynchotus*); (19) in dorsal view, shape of crista iliaca dorsalis at the acetabular area like straight line or only slightly curved (markedly curved in *Rhynchotus*); (20) cranial end of the ala praeacetabularis ilii not expanded laterally (markedly expanded in *Rhynchotus*); (21) in dorsal view, maximum width (at level of the acetabular area related to the cranial end of the praeacetabular area) slightly wider (nearly twice as wide as the praeacetabular width in *Tinamotis*). **Femur:** (22) crista trochanteris markedly projected with a deep fossa trochanteris (somewhat projected, but curved and medially directed with a shallow fossa in *Rhynchotus*); (23) in medial view, proximal terminus of cranial rim of the condylus medialis subequal to proximal terminus of caudal rim (much farther proximal in *Rhynchotus* and *Tinamus*); (24) shaft relatively straight (strongly curved in *Rhynchotus*). **Tibiotarsus:** (25) condylus lateralis distinctly longer than

medialis (subequal than medialis in *Tinamotis*); (26) short crista cnemialis cranialis, similar distal projection relative to the crista cnemialis lateralis (distinctly longer in *Rhynchotus* and *Tinamus*); (27) in cranial view, condylus lateralis elongated with rounded proximal end (subtriangular in shape, i.e. more pointed proximally and widens distally in *Tinamus*; short and rounded in *Tinamotis*). **Tarsometatarsus:** (28) significantly shorter than the femur (about the same length as the femur in *Tinamus*); (29) one proximally prominent crista hypotarsi (several well-developed cristae intermediate in *Tinamus*); (30) trochlea metatarsi II slightly less distally projected than trochlea IV, but reaching distally beyond as proximal margin of incisura intertrochlearis lateralis (much less distally projected than trochlea IV, without reaching proximal margin of incisura intertrochlearis lateralis in *Tinamus* and *Rhynchotus*; both trochleae about equally projected distally in *Tinamotis*).

Measurements. The total length of all the preserved bones of the specimen MPLK-03 exceeds the size range observed in the homologous elements of the *Eudromia* specimens available in this study (Table 1). Depending of the selected element, MPLK-03 is between 12 and 18% larger than those mean values of the compared *E. elegans* specimens ($n = 26$); and between 2.2 and 8% larger than the maximum values registered here for this species. Similarly, the total length of the bones in the fossil specimen is between 6 and 14% larger than the only specimen available of *E. formosa* (Table 1).

Discussion and conclusions

Systematic aspects

Both living species of *Eudromia* are almost indistinguishable in their postcranial elements with size ranges overlapped in most dimensions (Table 1). The specimen MPLK-03 cannot be morphologically distinguished from the skeletons of living forms but, however, it surpasses metrically the maximum range of measures here reported for *E. elegans* and *E. formosa* (Table 1).

Nevertheless, it is important to note the existence of two biases in the sample of available comparative specimens that could be important for the taxonomic identifying of the fossil specimen. While this study included a significant number of specimens of *E. elegans* (up to 26 specimens), all of them correspond to southern subspecies, not disposing representatives of the northern forms in the sample. Moreover, the available specimens included a single specimen of *E. formosa*. In relation to the latter, actually eight subspecies of *E. elegans* (*E. formosa* is currently considered monotypic, see Navas and Bó 1981) are recognized on the basis of differences in their plumage (Olrog 1959; Bohl 1970; Navas and Bó 1981). Within *E. elegans* subspecies, two well-defined groups are distinguished (Olrog 1959; Short 1975; Navas and Bó 1981; see Figure 3 (A)), a pampean-patagonian southern group (*E. e. multiguttata*, *E. e. elegans*, *E. e. patagonica*, *E. e. devia* and *E. e. albida*) and a chacoan northern group (*E. e. intermedia*, *E. e. riojana* and *E. e. magnistriata*).

Unfortunately, there are limited data on the size variation within different species and subspecies of the genus. According to the wing length measures published by Banks (1977), the northern forms of *E. elegans* appear to be slightly

Table 1. Measurements (in mm) for extant *Eudromia* species compared with MPLK-03 specimen here assigned to *Eudromia* sp. Values are expressed as follows: min–max, mean (n).

	<i>Eudromia elegans</i>	<i>Eudromia formosa</i>	MPLK-03
Coracoideum			
TL	34.32–40.11 37.16 (25)	39.74	42.13
W-fa	7.59–10.99 9.36 (25)	9.87	11.50
Humerus			
TL	57.23–67.04 62.74 (20)	65.17	72.24
W-prox	13.91–18.68 16.92 (23)	16.37	20.15
W-shaft	5.56–7.05 6.14 (20)	6.88	6.93
W-dist	11.80–14.28 12.76 (20)	13.24	14.30
Ulna			
TL	61.73–70.73 66.48 (6)	70.56	75.69
W-prox	10.10–11.13 10.55 (6)	11.18	12.11
W-dist	8.39–9.20 8.96 (6)	9.78	9.94
Radius			
TL	57.62–66.22 61.76 (6)	65.15	70.53
W-prox	6.58–7.17 6.76 (6)	7.22	7.49
Carpometacarpus			
TL	32.71–39.83 36.72 (12)	37.49	40.74
W-prox	10.2–11.06 10.59 (11)	11.87	12.10
W-dist	6.45–7.78 7.21 (12)	8.58	10.02
Pelvis			
TL	60.82–71.90 65.13 (17)	69.91	79.55
L-pre	34.12–39.27 36.66 (18)	39.82	43.10
L-post	31.32–36.91 34.17 (18)	36.42	43.64
Femur			
TL	48.86–62.98 58.68 (26)	61.57	68.47
W-prox	11.48–14.97 13.30 (26)	13.72	17.61
W-shaft	4.50–6.63 5.29 (26)	5.32	6.56
W-dist	10.67–14.41 12.38 (26)	13.05	15.03
Tibiotarsus			
TL	76.88–87.53 81.02 (26)		90.71
W-prox	10.76–15.48 14.24 (26)	12.44	17.73
W-shaft	4.18–5.41 4.79 (26)		5.90
W-dist	7.36–9.39 8.39 (26)		9.75
Tarsometatarsus			
TL	44.84–54.81 48.30 (14)		57.46
W-prox	8.57–10.30 9.51 (14)		10.98
D-prox	8.06–10.10 8.87 (14)		10.44
W-shaft	3.57–4.29 3.98 (14)		4.52
W-dist	9.54–11.68		12.23

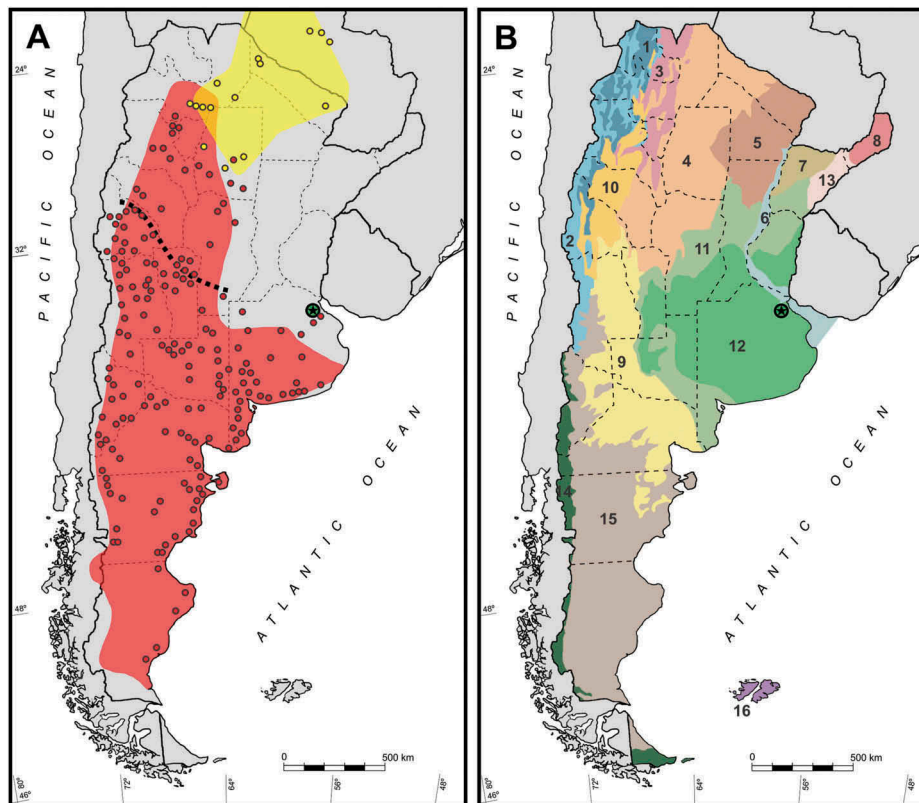


Figure 3. A. Modern geographic distribution of Crested Tinamou *Eudromia* spp. in Argentina: *E. elegans* (red area and dots), *E. formosa* (yellow area and dots). Continuous distribution areas are based on direct observation records according to eBird (2012) maps. Dots indicate localities with collected skins during XX century according to Olrog (1959), Bohl (1970), Banks (1977), Navas and Bó (1981). The black dotted line indicates the transitional boundary between northern and southern *E. elegans* ssp. according to Banks (1977), and Navas and Bo (1981). B. Continental ecoregions of Argentina modified of Brown and Pacheco (2006): Puna (1), High Andean (2), Yungas Forest (3), Dry Chaco (4), Humid Chaco (5), Delta and Islands of the Paraná River System (6), Iberá Swamps (7), Paranaense Forest (8), Monte of Plains and Steppes (9), Monte of Mountains and Isolated Valleys (10), Espinal (11), Pampas (12), Fields and Weedlands (13), Andean-Patagonian temperate rainforest (14), Patagonian Steppes (15), South Atlantic Islands (16). The star indicates the geographic location of the 'Nicolás Vignona III' Quarry where MPLK-03 was collected.

larger than the southern subspecies, between 6 and 8.5%. These percentages in the wing length increase of the northern forms of *E. elegans* with respect to the southern subspecies resemble the difference between the bones of new fossil individual and southern specimens available for comparison (mainly represented by *E. e. multiguttata* and *E. e. elegans*). If the wing length is positively correlated with the length of the wing elements, it could indicate a higher affinity of MPLK-03 with the Dry Chaco forms before than with the pampean-patagonian *E. elegans* subspecies.

However, based on the analysis of 240 skins, Navas and Bó (1981) considered that the wing measures do not resolve the taxonomy within *Eudromia* species or subspecies due to the broad overlap of their ranges. On the other hand, a weight examination of 84 specimens collected from seven of the eight *E. elegans* subspecies showed no outstanding differences between the form and sexes (Bohl). The data obtained from these specimens collected along the entire climatic gradient inhabited for the species (see Figure 3 (A)) show that Bergmann's rule is not verified within *E. elegans* subspecies. Here it is noteworthy that the largest individual of all of the subspecies collected belongs to *Eudromia e. multiguttata*, i.e. the most widely distributed subspecies in Buenos Aires Province (see Banks 1977; Navas and Bó 1981; Figure 3 (A)).

Taking into account the above considerations and on the basis the lack of conclusive evidence on the existence of body-

size differences between the living *Eudromia* populations, we conclude that the fossil specimen of *Eudromia* from Marcos Paz can be considered a large morph of *E. elegans* in a conservative approach or, alternatively, as a new species if its size is highlighted as the main and almost unique exclusive character of the purported new taxon. As we do not attempt to propose a theoretical discussion about the validity of chronological subspecies taxa (or chronoclines), we prefer choosing the first option and an open taxonomy for this fossil specimen, i.e., to avoid the erection of a new name until new findings are done, and additional *Eudromia* specimens are available for a more inclusive analysis on the body size variation in their living populations.

Palaeoenvironmental aspects

The species of *Eudromia* are nowadays inhabitants of arid and semiarid open environments with subtropical warm temperate to cold temperate climatic conditions. Both extant species mainly occur in allopatry with minimum overlap in their ranges (Banks 1977; Navas and Bó 1981; Cabot 1992; Echarri et al. 2009; Figure 3 (A)).

Eudromia formosa inhabits northern Argentina, being also found at the western Paraguayan Chaco (Banks 1977; Navas and Bó 1981; Figure 3 (A)). Quebracho woodland and other dry forests, as well as grasslands, of the Chaco region are the preferred habitats of *E. formosa* (Cabot 1992; Figure 3 (B)).

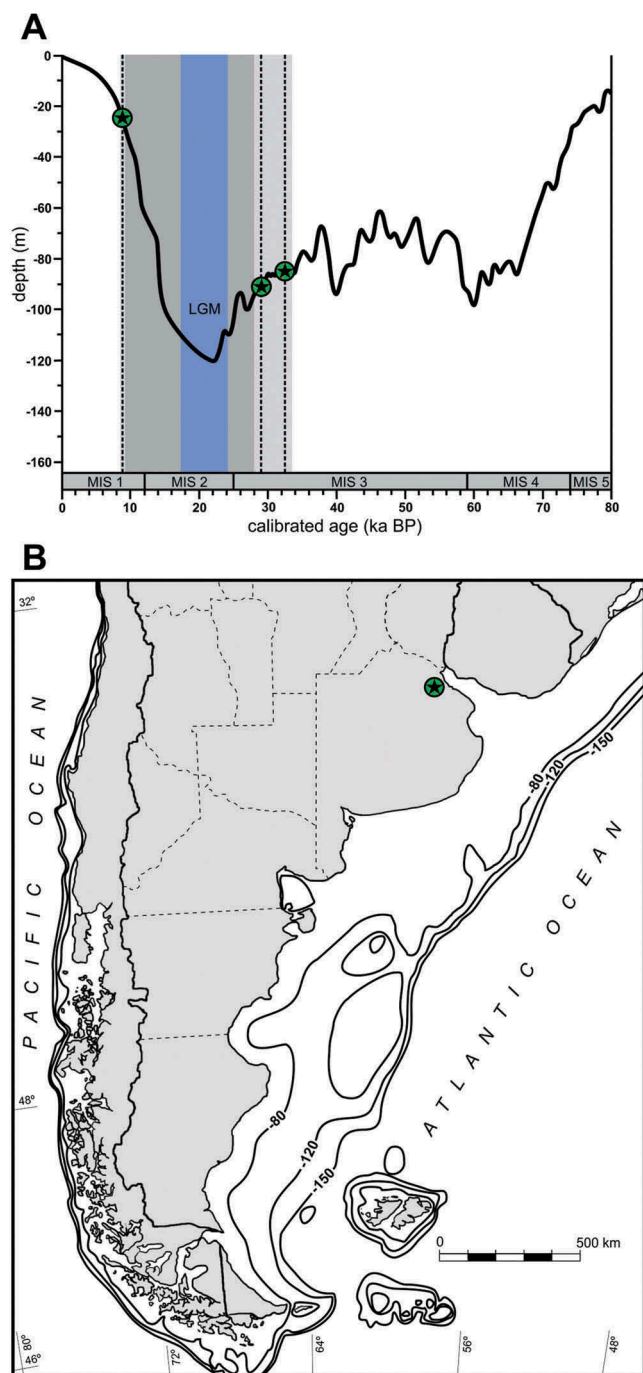


Figure 4. A. Reconstruction of the regional eustatic sea-level changes (black curve) during the Last Glacial period. B. Argentine shelf morphology related to 80, 125 and 150 m sea-level drops. Both schemes modified from Kaiser and Lami (2010). The stars indicates the ages (in A) and geographic location (in B) of the samples dated ($32,580 \pm 1,520$; $29,070 \pm 1,420$ and $8,480 \pm 130$ RCYBP) taken at the 'Nicolás Vignona III' Quarry where MPLK-03 was collected. In blue Last Glacial Maximum time span (see text).

The *E. elegans* ssp. are distributed in a very wide latitudinal range of 3000 km over the Northwest, West, Central and Southwest of Argentina (between latitudes 26° S, southern Salta Province; and 51° S, southern Santa Cruz Province; Cabot 1992; Bohl 1970; Figure 3 (A)). Throughout its wide range, *E. elegans* occupies arid and semiarid grassland, dry savanna, open woodland, dry Andean steppes, bare hills with isolated patches of bushes and cultivation (Figure 3 (B)). In

temperate zone of Central Argentina, it prefers sandy areas with thorn scrub and low evergreen bushes (Cabot 1992).

A recent bioclimatic analysis of *Eudromia* spp. concluded that the precipitation is the most influent factor between their climatic profiles, with *E. formosa* inhabiting warmer and wetter sites than *E. elegans* and the latter preferring lowest temperatures and drier areas (Echarri et al. 2009).

The absolute dates obtained for snails shells found at underlying ($32,580 \pm 1,520$ and $29,070 \pm 1,420$ RCYBP) and overlying units ($8,480 \pm 130$ RCYBP) restrict the age of deposition of the avian bearing sediments to the cold period between the late MIS 3 and early MIS 1 times (ca. 30–10 ka BP). Although the Patagonian ice sheets had their maximum expansion during Last Glacial Maximum (LGM, 24–17 ka, e.g. Kaplan et al. 2008; Rabassa 2008; Moreno et al. 2015), pre-LGM glaciations in Patagonia have been registered in the late MIS 3 (e.g. Zech et al. 2011; Darvill et al. 2015), as well as other advances during the Lateglacial (correlated with the Antarctic Cold Reversal, ca. 14,6–12,8 ka, e.g. Garcia et al. 2012; and/or Younger Dryas, 12,9–11,7 ka, e.g. Kaplan et al. 2008). The glacial-eustatic movements caused by the accumulation of ice led to a dramatic drop in sea level with the consequent exposure of a large portion of the Argentine continental shelf and the development of vast coastal plains along of Patagonian-Pampean regions (Rabassa et al. 2005; Ponce et al. 2011; Ponce and Rabassa 2016).

Palaeogeographic reconstructions of the Argentine shelf morphology and the sea-level changes during early MIS 3 and MIS 2 times show that the sea-level dropped between -80 m and -120 m (Figure 4 (A)–(B), Kaiser and Lami 2010; Ponce et al. 2011; Ponce and Rabassa 2016), doubling the present emerged surface and intensified the continental climate conditions. Also the suggested displacement of the Malvinas-Falklands current towards the east, as a result of a diminution of the depth between Patagonia and Malvinas-Falklands islands (Rabassa et al. 2005), would have generated a significant rise of continental climate conditions along the present coastal environments. The northward displacement of the southern Pacific anticyclone determined the arrival of the cold and dry Westerlies winds to the more central regions (e.g. Clapperton 1993; Compagnucci 2011; Zech et al. 2011). The increasing aeolian activity led to the development of intensive deflation processes, with the formation of extensive dune fields in northern Patagonia and the western Pampean region, as well as the accumulation of large loess banks in the NE of the Buenos Aires and Entre Ríos provinces, but also Uruguay and southern Brazil (Iriondo and Kröhling 1995; Iriondo 1999; Rabassa et al. 2005; Kaiser and Lami 2010).

More continental climatic conditions during MIS 2 in Patagonian and Pampean regions led to an increase in extreme temperatures, deflation processes, and reduction of precipitation and vegetable cover on the soils. These changes generated shifts on the dominant floristic physiognomies with an expansion to north and eastward of Monte and steppe Patagonian ecosystems (Rabassa et al. 2005).

Taking into account the habitat preferences of the extant species of *Eudromia* exposed above and considering that the fossil location is more than 250 km east of the

eastern distributional limit of the nearest extant populations of *E. elegans* and more than 800 km southeast of the limit of *E. formosa*, this geographical outlier could be tentatively associated with the expansion of arid or semi-arid paleoenvironments typical of the Central or Patagonian domains over the temperate Pampean grasslands during the MIS 2 times.

However, until thorough sedimentological, palaeobotanical and more extensive faunistic assemblages studies can provide the necessary information to reconstruct more accurately the environmental scenarios of the Pampean region around of the LGM times, it will be difficult to assess strong palaeoecological inferences based on isolated records of taxa.

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No potential conflict of interest was reported by the authors.

ORCID

Marcos Cenizo  <http://orcid.org/0000-0001-9301-0205>

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