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A SMALL SYNSACRUM OF AN ENIGMATIC BIRD FROM THE EOCENE OF MARAMBIO (SEYMOUR) ISLAND: INSIGHTS INTO THE ANTARCTIC AVIFAUNA

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Abstract. A small, incomplete synsacrum from Ypresian (early Eocene) levels of the *Cucullaea* I Allomember (La Meseta Alloformation) on Marambio (Seymour) Island, Antarctica, is examined. The synsacrum, which is dorsoventrally depressed and laterally widened, preserves two complete and one incomplete fused vertebrae. It exhibits a *crista ventralis synsacri* instead of the more typical *sulcus ventralis synsacri* observed in most Neornithes. Notable features include the presence of large, oval *foramina intervertebralia* that pierce the *corpus synsacri* and lateral concavities. Extensive comparisons with a broad sample of extant and extinct birds, including representatives of Tinamiformes, Anseriformes, Podicipediformes, Rallidae, Charadriiformes, Gaviiformes, Sphenisciformes, Procellariiformes, Phalacrocoracidae, Strigiformes, Accipitriformes, Phorusrhacidae, Falconiformes, and Pelagornithidae, reveal partial similarities with certain Charadriiformes but no exact match among the studied taxa. Given its unique combination of characters and its incomplete nature, the material is referred as an indeterminate Neognathae. Although a more precise taxonomic assignment is not possible, this synsacrum provides novel anatomical information as evidence of a small marine bird or shorebird in the Eocene of Antarctica. It underscores the significance of fragmentary postcranial elements in reconstructing past ecosystems and reveals a greater complexity in the structure of these avian communities than previously recognized.

Key words. Cenozoic. Charadriiformes. Fossil avifauna. James Ross Basin. La Meseta Formation. Paleogene. Neornithes. Neognathae.

Resumen. UN PEQUEÑO SINSACRO DE UN AVE ENIGMÁTICA DEL EOCENO DE LA ISLA MARAMBIO (SEYMOUR): APORTES A LA AVIFAUNA ANTÁRTICA. Se examina un sinsacro pequeño e incompleto proveniente de niveles ypresianos (Eoceno temprano) del Alomiembro *Cucullaea* I (Aloformación La Meseta) en la Isla Marambio (Seymour), Antártida. El sinsacro, dorsoventralmente deprimido y lateralmente ensanchado, preserva dos vértebras fusionadas completas y una incompleta. Presenta una *crista ventralis synsacri* en lugar del *sulcus ventralis synsacri* más típico observado en la mayoría de los Neornithes. Entre los rasgos más destacados se incluyen la presencia de grandes *foramina intervertebralia* de contorno oval que perforan el *corpus synsacri* y concavidades laterales. Comparaciones exhaustivas con una amplia muestra de aves actuales y fósiles, que incluye representantes de Tinamiformes, Anseriformes, Podicipediformes, Rallidae, Charadriiformes, Gaviiformes, Sphenisciformes, Procellariiformes, Phalacrocoracidae, Strigiformes, Accipitriformes, Phorusrhacidae, Falconiformes y Pelagornithidae, revelan similitudes parciales con ciertos Charadriiformes, pero sin una correspondencia exacta con ninguno de los taxones analizados. Dada su combinación única de caracteres y su estado incompleto, el material es referido a Neognathae indeterminado. Si bien no es posible una asignación taxonómica más precisa, este sinsacro aporta información anatómica novedosa como evidencia de un ave marina o costera de pequeño tamaño en el Eoceno de la Antártida. Asimismo, destaca la importancia de los elementos postcraneanos fragmentarios para la reconstrucción de ecosistemas pasados y revela una mayor complejidad en la estructura de estas comunidades avianas de lo que se reconocía previamente.

Palabras clave. Cenozoico. Charadriiformes. Avifauna fósil. Cuenca de James Ross. Formación La Meseta. Paleógeno. Neornithes. Neognathae.

INTRODUCTION

The fossil record of Antarctic birds is largely restricted to the James Ross Basin. The sediments exposed across this archipelago, particularly on Marambio (Seymour) Island, located east of the Antarctic Peninsula, contain a nearly continuous sequence from the late Cretaceous to the late Eocene, possibly extending into the early Oligocene. This succession preserves the most extensive collection of Cenozoic birds known from Antarctica (Acosta Hospitaleche et al., 2019)

This avifaunal record is dominated by penguins (Sphenisciformes), represented by thousands of specimens spanning a wide range of body sizes, including both dwarf and giant forms (Myrcha et al., 2002; Jadwiszczak, 2006; Acosta Hospitaleche et al., 2019; Jadwiszczak et al., 2021). In contrast, remains of flying and cursorial birds are comparatively scarce. Nevertheless, recorded groups such as Falconiformes, Procellariiformes, Pelagornithidae, Ratites, Gruiformes, Anseriformes, and Phorusrhacidae (Cenizo et al., 2015; Acosta Hospitaleche & Gelfo, 2017; Acosta Hospitaleche et al., 2019; Acosta Hospitaleche & Jones, 2024) indicate a remarkable diversity in the region during this period.

Most non-penguin fossils are fragmentary, a condition that complicates a precise taxonomic assignment. This incompleteness reflects a pronounced taphonomic bias favoring diving birds, driven mainly by two factors: the inherent osteosclerotic nature of their bones, which increases preservation potential (Gardner et al., 2016), and the marine origin of the entire sedimentary sequence (Marenssi et al., 1998a, 1998b), which preferentially preserves marine fauna. Consequently, fossils of continental birds are rare, and each new discovery, therefore, represents a critical piece of evidence for reconstructing the Antarctic Eocene avian communities.

Bones from the pelvic and sacral regions are particularly valuable, as their morphology offers key insights into both locomotion and taxonomic affinities (Necker, 2005, 2006; Kaiser, 2007; Livezey & Zusi, 2007). The synsacrum, a single element formed by the postnatal fusion of the last thoracic, lumbar, sacral, and first caudal vertebrae, is a key structure in this regard. Its morphology reflects locomotor habits and phylogenetic relationships, often bearing diagnostic characters that can distinguish major avian groups (Baumel & Witmer, 1993; Livezey & Zusi, 2007).

A partial synsacrum from Ypresian (early Eocene) levels of the La Meseta Alloformation on Marambio (Seymour) Island is described here. This specimen displays morphological characters that allow discussion of its possible affinities with avian lineages recorded in the region, as well as with other groups that may have inhabited Antarctica during this time. The primary objectives are to provide a detailed morphological description and to use comparative evidence to refine current understanding of the composition of Antarctic avifauna during the Eocene.

GEOLOGICAL SETTING

Specimen IAA-Pv 1110 was collected in Marambio (Seymour) Island (Fig. 1A), a small island near the north-eastern tip of the Antarctic Peninsula (Fig. 1B). The island exposes a sedimentary sequence (Fig. 1C) over 2 km thick that represents the upper part of the James Ross Basin infill (Marenssi et al., 1998a; Montes et al., 2019). In its northern sector, three main units constituting the infill of incised valleys crop out: the Cross Valley Formation (upper Paleocene), the La Meseta Alloformation (Paleocene–Eocene), and the Submeseta Alloformation (Eocene–?Oligocene). Within La Meseta Alloformation, the six allomembers Valle de las Focas, Acantilados I, Acantilados II, Campamento, *Cucullaea* I, and *Cucullaea* II, are deposited from bottom to top (Montes et al., 2019).

The *Cucullaea* I Allomember, equivalent to level 35 (Montes et al., 2013), crops out around the base of the plateau with a maximum thickness of 90 m (Fig. 1A, C). It was deposited during the late Ypresian (early Eocene) and is exposed at several localities, among which is IAA 1/90 (Fig. 1A, C), the site where the synsacrum IAA-Pv 1110 (Fig. 2A–F) was found. This allomember is subdivided into several shell-rich horizons named $35Cu_1$, $35Cu_2$, 35Na, $35Cu_3$, and $35Cu_4$ (Montes et al., 2019), from which the most laterally extensive are $35Cu_1$ and $35Cu_2$ (Montes et al., 2013). These coquina levels are characterized by a high concentration of *Cucullaea raea* and limited bioturbation, restricted to finer-grained intervals. Above them, the succession becomes progressively sandier and more intensely bioturbated, culminating in a coquina horizon (35Na) composed almost entirely of *Natica* sp., from which the material under study derives. Overlying this level, two additional shell beds, $35Cu_3$ and $35Cu_4$ have been described in other coetaneous localities (Montes et al., 2019). The depositional environment of the fossil locality IAA 1/90 was interpreted as estuarine to shallow marine.

MATERIALS AND METHODS

Materials

The synsacrum IAA-Pv 1110 is housed at the Repositorio Antártico de Colecciones Paleontológicas y Geológicas (IAA-Pv) of the Instituto Antártico Argentino (San Martín), Argentina. The comparative material (Appendix 1) was

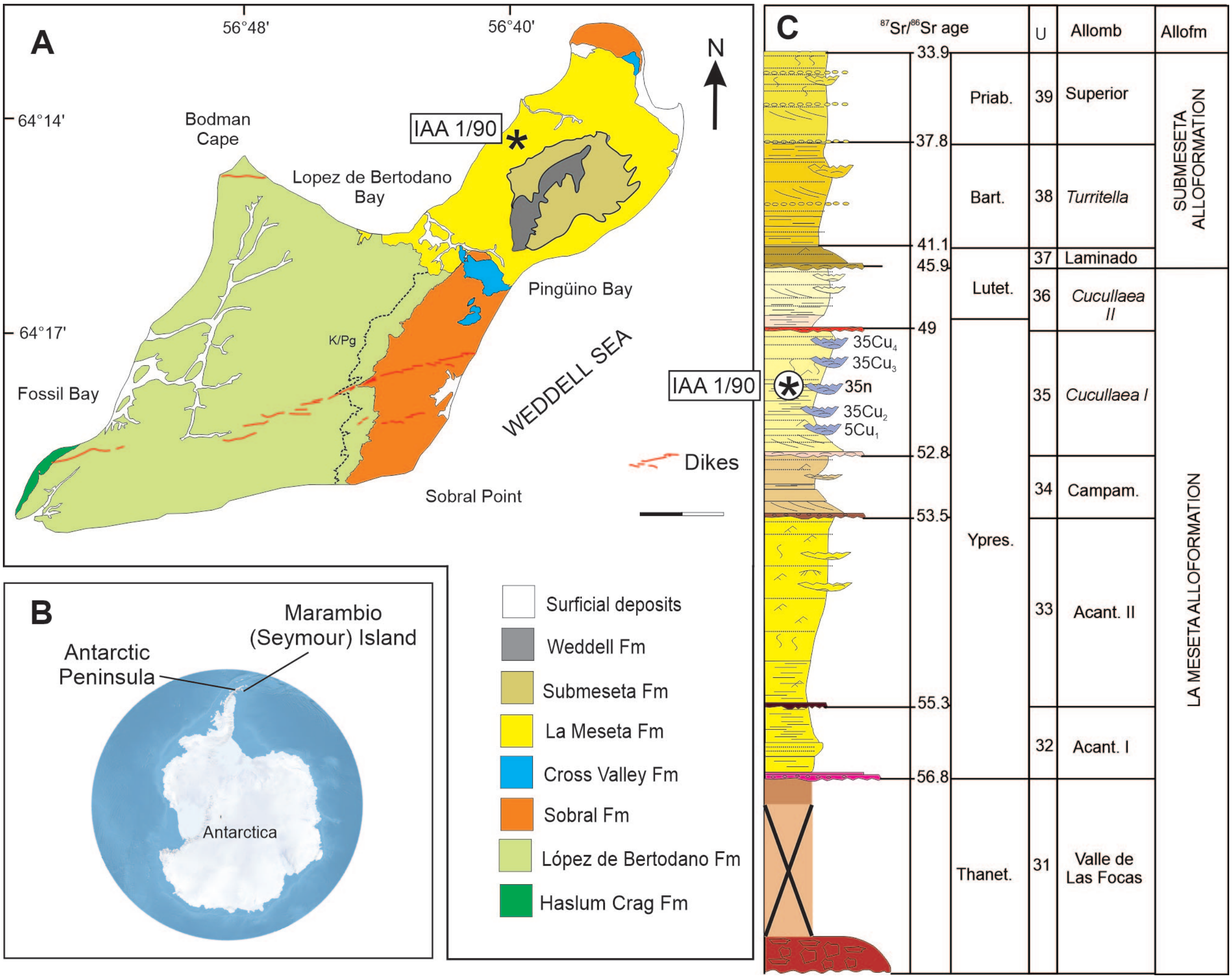

Figure 1. Location map. A, Marambio (Seymour) Island; B, Antarctic Peninsula; C, Stratigraphic column. Scale = 1 km. Abbreviations: Acant., Acantilados; Allomb, Allomember; Allofm, Alloformation; Bart., Bartonian; Campam., Campamento; Lutet., Lutetian; Priab., Priabonian; Thanet., Thanetian; U, unit; Ypres., Ypresian. The fossiliferous locality is indicated with an asterisk and labeled as IAA 1/90. The map and the stratigraphic columns were modified from Montes et al. (2019).

selected based on the current distribution of birds, their biogeographic history, the fossil record, and the depositional environment. It includes specimens of the Sección Ornitología of the *Museo de La Plata*, La Plata, Argentina (MLP-ORN) and material from the Division of Birds, National Museum of Natural History, Smithsonian Institution (USNM), accessed through its website (https://collections.nmnh.si.edu/search/birds). Specimens from the Institut Royal des Sciences Naturelles de Belgique, Belgium (IRSNB), the Natural History Museum of Los Angeles County, USA (LACM), and the *Museo Nacional de Historia Natural*, Santiago, Chile (MNHN SGO.PV) were compared using published images.

Methods

Anatomical terminology used in descriptions and comparisons follows Baumel and Witmer (1993). Ventral, dorsal, and lateral orientations of the synsacrum were established and consistently applied in the description of the material in that order. Measurements were taken with a digital Vernier caliper accurate to 0.01 mm.

Institutional abbreviations. IAA-Pv, *Repositorio Antártico de colecciones Paleontológicas y Geológicas del Instituto Antártico Argentino, colección Paleovertebrados*; **MLP-ORN,** *Sección Ornitología, Museo de La Plata*; **USNM,** US National Museum of Natural History, Paleobiology collection; **IRSNB,** Institut Royal des Sciences Naturelles de Belgique, Belgium; **LACM,**

The Natural History Museum of Los Angeles County; **MNHN SGO.PV,** *Museo Nacional de Historia Natural*, Chile.

RESULTS

SYSTEMATIC PALEONTOLOGY

AVES Linnaeus, 1758
NEORNITHES Gadow, 1883
NEOGNATHAE Pycraft, 1900
Gen. et sp. indet.
Figures 2A–F

Material. IAA-Pv 1110. Sacro-caudal segment (segment III and IV of Boas, 1933) of the synsacrum.

Provenance. Fossiliferous locality IAA 1/90, Ypresian (early Eocene) levels of the *Cucullaea* I Allomember of the La Meseta Alloformation. Marambio (Seymour) Island, Antarctica (Fig. 1A–C).

Description. The preserved portion represents the sacro-caudal segment of a small, cylindrical synsacrum that tapers caudally (see measurements in Table 1). It consists of two complete vertebrae and the cranialmost incomplete vertebra (Fig. 2A–F), all fully fused and with no visible sutures, a condition that indicates the adult age of the specimen.

The *corpus synsacri* is dorsoventrally depressed and mediolaterally wide. In the ventral view, the absence of a *sulcus ventralis synsacri* is notable, but a faint *crista ventralis synsacri* is present (Fig. 2A), which gives the cross-section of the element a triangular outline. The *foramen vertebrale* is round and large relative to the vertebral body (Fig. 2B, C).

Dorsally, the *crista spinosa synsacri* is low, broad, and slightly convex, and extends to the first vertebra of the synsacrum that is homologous to a sacral vertebra (Fig. 2D). The *processi transversi* are not preserved; however, their bases indicate that the cranial ones were relatively small, dorsally positioned, and rounded, while the more caudal

TABLE 1. Measurements (mm) of IAA-Pv 1110.

Total length	10.27
Cranial height	3.99
Caudal height	3.59
Width	4.28

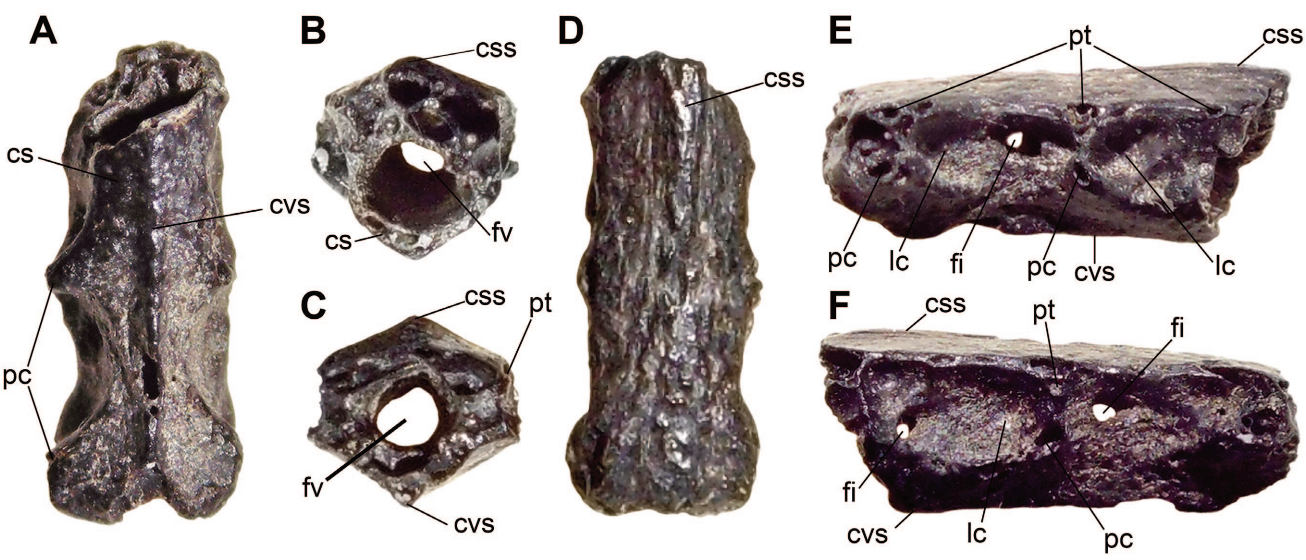

Figure 2. Synsacrum IAA-Pv 1110 in A, ventral view; B, cranial view; C, caudal view; D, dorsal view; E, right lateral view; F, left lateral view. Scale bar = 10 mm. Abbreviations: cs, *corpus synsacri*; css, *crista spinosa synsacri*; cvs, *crista ventralis synsacri*; fi, *foramen intervertebrale*; fv, *foramen vertebrale*; lc, lateral concavity; pc, *processus costalis*; pt, *processus transversus*.

processes were larger. Beneath the cranial processes, small and rounded bases of *processi costales* are observable (Fig. 2E, F).

Between adjacent vertebrae, large and oval *foramina intervertebralia* are fully open, allowing communication through the bone from one lateral surface to the other of the *corpus synsacri*. Posterior to these foramina, and immediately before the origins of the transverse and costal processes, are distinct shallow concavities (Fig. 2E, F).

Despite its incompleteness, the specimen preserves sufficient characters to support comparisons with several avian lineages recorded in the Eocene of Antarctica, which are addressed in the following discussion.

DISCUSSION

The synsacrum IAA-Pv 1110, although fragmentary, preserves a set of anatomical characters that allows comparisons with both extant and fossil species (Fig. 3A, B). In birds, the synsacrum is a complex element formed by the fusion of several vertebrae, and its morphology varies among major avian lineages in relation to both phylogenetic relationships and locomotor adaptations (Baumel & Witmer, 1993; Livezey & Zusi, 2007). Consequently, even partial synsacra may retain characters of systematic relevance. In this sense, although other groups such as the xenarthrans also present a synsacrum, IAA-Pv 1110 exhibits a set of characters that allow its assignment to Aves. The antero-posterior axis is straight as in most groups of birds, both *processus transverssus* and *processus costalis* are present, the *crista spinosa synsacri* is lower, the *foramina intervertebralia* are present, the *corpus vertebra* is proportionally taller, and the bone is pneumatized.

The preserved portion of IAA-Pv 1110 is dorsoventrally depressed and mediolaterally wide, lacks a *sulcus ventralis synsacri*, and instead exhibits a *crista ventralis synsacri* that gives the *corpus synsacri* a triangular cross-section in cranial view. In addition, large oval *foramina intervertebralia* perforate the *corpus synsacri* from one lateral side to the other, and shallow lateral concavities are present adjacent to the bases of the *processi transversi* and *processi costales*. The morphology of these structures indicates that they represent original anatomical characters rather than taphonomic deformation.

Comparative assessments of IAA-Pv 1110 are primarily focused on avian groups known from the Paleogene of Antarctica, as well as taxa currently inhabiting the region.

Within these avian groups, comparisons are mainly restricted to Neognathae, given that Paleognathae exhibit a distinct synsacral morphology. Tinamidae (Fig. 3C, D), for example, have a *sulcus ventralis synsacri* and a *crista spinosa synsacri* well-developed, reaching the caudal end of the bone. They, however, lack the lateral concavities present in IAA-Pv 1110. In Casuariidae and Rheidae, in turn, the *sulcus ventralis synsacri* in the sacro-caudal segment is absent, and the *crista spinosa synsacri* is high, fusing with the pelvis along the midline, differing from the low and rounded *crista spinosa synsacri* of IAA-Pv 1110.

Among Neognathae, the best represented group in the Eocene of Marambio Island corresponds to Sphenisciformes (Jadwiszczak, 2006, 2014; Jadwiszczak et al., 2023). In these taxa, the synsacrum also exhibits a well-developed s*ulcus ventralis synsacri* (Fig. 3E) and small *foramina intervertebralia* that clearly distinguish them from IAA-Pv 1110. Besides, penguins have a notably more robust morphology typical of highly specialized diving habits.

Anseriformes differ from the fossil specimen, as they present a robust synsacrum with the *sulcus ventralis synsacri* present only in the sacral region (Fig. 3F, G), lack a *crista ventralis synsacri*, lateral concavities, and a *crista spinosa synsacri*. Other diving birds, such as Suliformes (Fig. 3H) and Gaviiformes (Fig. 3I), possess a synsacrum that is strongly laterally compressed and dorsoventrally tall, with wide *processi transversi*, and lacking both a *crista ventralis synsacri* and *foramina intervertebralia* piercing the *corpus synsacri*. Gaviiformes also present a well-developed *sulcus ventralis synsacri*. Podicipediformes (Fig. 3J) can also be excluded, as their synsacra generally present a more developed *crista spinosa synsacri* and reduced f*oramina intervertebralia*, wide *processi transversi*, and the absence of the *crista ventralis synsacri*. This differs from the low and rounded *crista spinosa synsacri* and the open *foramina intervertebralia* present in IAA-Pv 1110.

Meaningful comparisons with Pelagornithidae are not possible; the two specimens with synsacral elements, *Pelagornis chilensis* and *Pelagornis* sp. (Mayr & Rubilar-Rogers, 2010, fig. 3A; Mayr et al., 2013, figs. 1.5–1.9), only

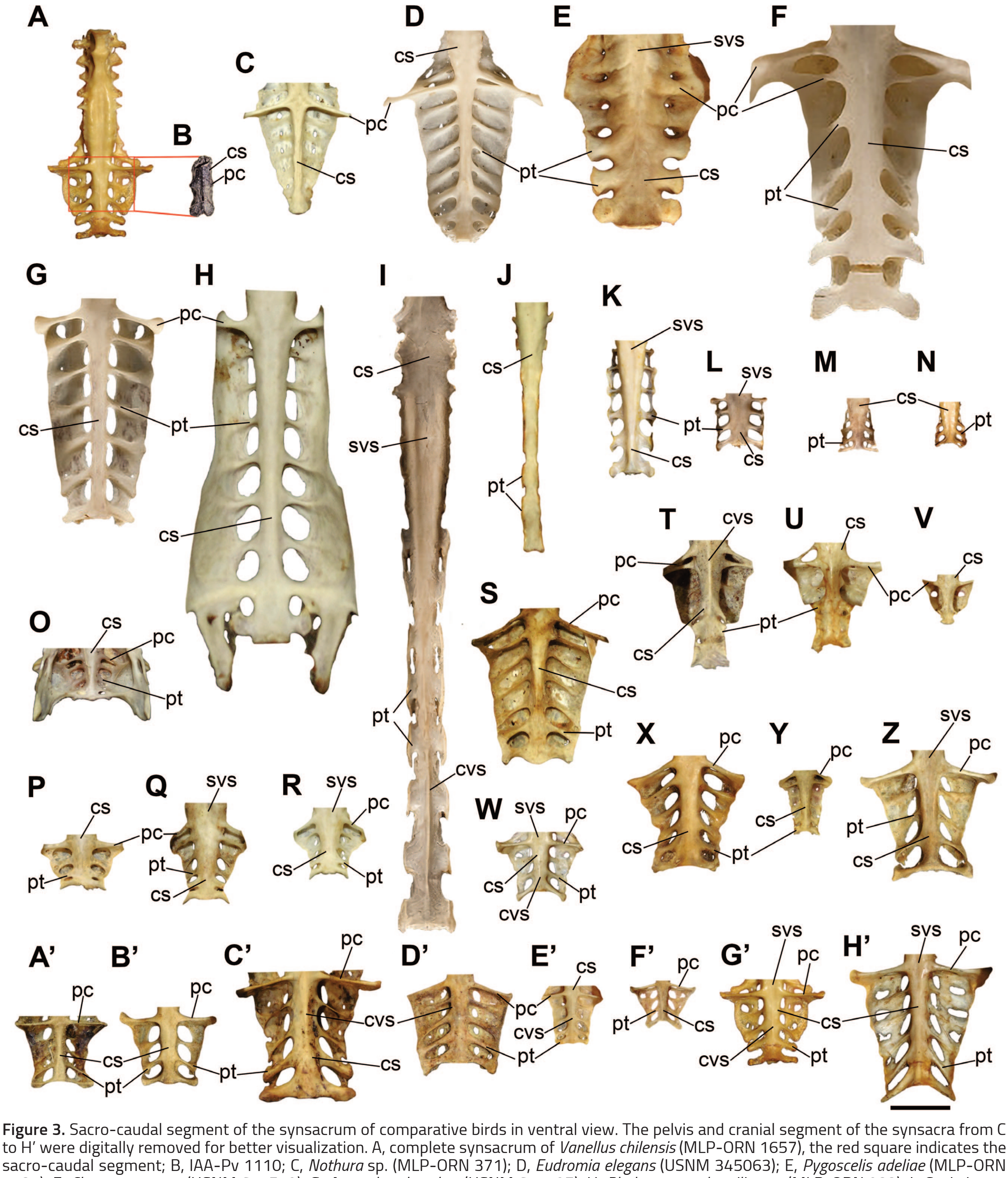

Figure 3. Sacro-caudal segment of the synsacrum of comparative birds in ventral view. The pelvis and cranial segment of the synsacra from C to H' were digitally removed for better visualization. A, complete synsacrum of *Vanellus chilensis* (MLP-ORN 1657), the red square indicates the sacro-caudal segment; B, IAA-Pv 1110; C, *Nothura* sp. (MLP-ORN 371); D, *Eudromia elegans* (USNM 345063); E, *Pygoscelis adeliae* (MLP-ORN 1134); F, *Chauna torquata* (USNM 614549), G, *Anas platyrhynchos* (USNM 621197), H, *Phalacrocorax brasilianum* (MLP-ORN 983); I, *Gavia immer* (USNM 502462); J, *Podiceps major* (MLP-ORN 844); K, *Puffinus puffinus* (USNM 610341); L, *Pelecanoides urinatrix* (USNM 553243); M, *Oceanodroma leucorhoa* (USNM 614217); N, *Oceanites oceanicus* (MLP-ORN 1905); O, *Falco sparverius* (MLP-ORN 2336); P, *Rupornis magnirostris* (MLP-ORN 362); Q, *Tyto furcata* (MLP-ORN 2048); R, *Asio otus* (MLP-ORN 541); S, *Ortalis* sp. (MLP-ORN 400); T, *Aramides cajaneus* (MLP-ORN 2156); U, *Porphyrio martinica* (MLP-ORN 631); V, *Pardirallus sanguinolentus* (MLP-ORN 791); W, *Himantopus melanurus* (MLP-ORN 657); X, *Chionis albus* (MLP-ORN 606); Y, *Jacana jacana* (MLP-ORN 730); Z, *Larus dominicanus* (MLP-ORN 2174); A', *Sterna vittata* (MLP-ORN 2161); B', *Chroicocephalus maculipennis* (MLP-ORN 2178); C', *Stercorarius maccormicki* (MLP-ORN 1847); D', *Attagis malouinus* (MLP-ORN 2046); E', *Gallinago paraguaiae* (MLP-ORN 731); F', *Tringa solitaria* (MLP-ORN 2087); G', *Vanellus chilensis* (MLP-ORN 1657); H', *Haematopus palliatus* (MLP-ORN 615). Scale bar = 10 mm. Abbreviations: cs, *corpus synsacri*; cvs, *crista ventralis synsacri*; pc, *processus costalis*; pt, *processus transversus*, svs, *sulcus ventralis synsacri*.

preserve the cranial portion of the synsacrum, whereas IAA-Pv 1110 represents a sacro-caudal segment. However, although elements do not overlap and cannot be directly compared, all Pelagornithidae, even the smaller ones (see Cenizo et al., 2015: fig. 7), considerably exceed the size of IAA-Pv 1110.

In Procellariiformes, Diomedeidae, Diomedeoididae, and Procellariidae (Fig. 3K, L) have a synsacrum with a well-developed to slightly marked *sulcus ventralis synsacri*, which is absent in Hydrobatidae (Fig. 3M) and Oceanitidae (Fig. 3N). All Procellariiformes also present small foramina intervertebralia, whereas the lateral concavities are absent.

Falconiformes, Accipitriformes, Strigiformes and Cracidae (Galliformes) (Fig. 3O–S) present a conspicuous *sulcus ventralis synsacri* and small or absent *foramina intervertebralia* not completely perforating the *corpus synsacri*. In addition, the overall proportions and ventral outline of the synsacrum differs from the dorsoventrally depressed morphology and triangular section observed in the fossil IAA-Pv 1110.

Phorusrhacidae (Cariamiformes) share with IAA-Pv 1110 the presence of a *crista ventralis synsacri* spanning the entire sacral region to the caudal end of the bone. However, even in the smaller species, the synsacrum of Phorusrhacidae is notably more robust and compressed than in IAA-Pv 1110 (see Degrange, 2012, fig. 4.19).

Some similarities are also observed with certain Gruiformes, particularly within Rallidae. The presence of a *crista ventralis synsacri* was observed in *Aramides cajaneus* (Fig. 3T), whereas most of the Rallidae exhibit a shallow *sulcus ventralis synsacri* (Fig. 3U, V). In addition, rallids also lack *foramina intervertebralia* completely perforating the *corpus synsacri*, and lateral concavities are absent. Therefore, none of the examined species of Rallidae present the same configuration that IAA-Pv 1110.

The closest morphological resemblances to IAA-Pv 1110 are observed within Charadriiformes (Fig. 3W–H'). Several representatives of this order, particularly Recurvirostridae, Chionidae, Jacanidae, Laridae, Stercorariidae, some Thinocoridae, certain Scolopacidae and Charadriidae, exhibit *foramina intervertebralia* and lateral concavities in the *corpus synsacri*. These similarities suggest a comparable synsacral morphology in small to medium-sized, primarily coastal or shore-associated birds. However, several important differences are also observed. In all Charadriiformes examined, the *foramina intervertebralia* are proportionally smaller and do not completely perforate the *corpus synsacri*, as does occur in IAA-Pv 1110. In addition, in most Charadriiformes the ventral surface of the synsacrum bears a *sulcus ventralis synsacri* (Fig. 3W, Z, B', G'), whereas in others, such as Haematopodidae (Fig. H'), this sulcus is absent; however, a *crista ventralis synsacri* is also lacking, except in Chionidae and some Scolopacidae as *Gallinago paraguaiae* (Fig. 3E'). The synsacrum exhibits a predominantly cylindrical section rather than triangular, as is observed in IAA-Pv 1110.

CONCLUSION

Synsacra are rarely preserved as complete elements in the fossil record; consequently, each new finding, even when fragmentary, provides an opportunity to expand current knowledge of the anatomical and taxonomic diversity of Antarctic fossil birds. IAA-Pv 1110 shares the presence of open *foramina intervertebralia* and lateral concavities with certain Charadriiformes, and the presence of a *crista ventralis synsacri* with rallids. However, the absence of a *sulcus ventralis synsacri*, the marked development of the *foramina intervertebralia*, and the triangular cross-section of the *corpus synsacri* represent a unique combination of characters not observed in any other compared bird. For this reason, although possible affinities with Charadriiformes are suggested, IAA-Pv 1110 is provisionally assigned to a small indeterminate Neognathae.

Although Charadriiformes have not yet been recorded in Antarctica, their presence is entirely plausible given their biochronological distribution, paleoenvironmental reconstructions, and the inferred depositional setting of the *Cucullaea* I Allomember. This unit has been interpreted as representing estuarine to shallow-marine conditions (Marenssi et al., 1998b), environments that today are commonly inhabited by a wide variety of marine and shorebirds. Accordingly, IAA-Pv 1110 may represent the first record of a small-sized charadriiform from the Eocene of the Antarctic continent. Birds of this size typically possess extremely fragile skeletons, making them particularly susceptible to destructive taphonomic processes. This likely explains their absence in the fossil record of the region, and particularly in the *Cucullaea* I Allomember levels, where the best-preserved remains usually correspond to more resistant elements, such as mammalian teeth or the apneumatic bones of penguins. This interpretation is further supported by the fact that the only known pelagornithid specimen from locality IAA 1/90 (Acosta Hospitaleche & Reguero, 2020) is incomplete and heavily weathered.

Nevertheless, the discovery of IAA-Pv 1110 is highly significant, as it contributes to a more complete picture of the non-penguin avifauna inhabiting the Antarctic coasts during the Eocene. It also supports the existence of a more complex structure of avian communities than previously recognized.

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APPENDIX 1

Paleognathae
Tinamidae: *Nothura* sp. MLP-ORN 371; *Eudromia elegans* USNM 345063
Casuariidae: *Casuarius casuarius* USNM 429823
Rheidae: *Pterocnemia pennata* USNM 621378

Anseriformes
Anhimidae: *Chauna torquata* MLP-ORN 1356, USNM 614549
Anatidae: *Lophonetta specularoides* MLP-ORN 2174; *Mareca sibilatrix* MLP-ORN 2195; *Anas platyrhynchos* USNM 621197
Anseranatidae: *Anseranas semipalmata* USNM 347638

Galliformes
Cracidae: *Ortalis* sp. MLP-ORN 400

Podicipediformes
Podicipedidae: *Podiceps major* MLP-ORN 844

Gruiformes
Rallidae: *Fulica leucoptera* MLP-ORN 735; *Porphyrio martinica* MLP-ORN 631; *Pardirallus sanguinolentus* MLP-ORN 791; *Gallinula chloropus* MLP-ORN 1051; *Aramides cajaneus* MLP-ORN 2156

Charadriiformes
Chionidae: *Chionis albus* MLP-ORN 606, MLP-ORN 608.
Recurvirostridae: *Himantopus mexicanus* MLP-ORN 657, MLP-ORN 1655
Haematopodidae: *Haematopus palliatus* MLP-ORN 615, MLP-ORN 656
Charadriidae: *Vanellus chilensis* MLP-ORN 1657, MLP-ORN 1925; *Vanellus vanellus* USNM 556301
Thinocoridae: *Attagis malouinus* MLP-ORN 2046; *Thinocorus rumicivorus* MLP-ORN 1861
Jacanidae: *Jacana jacana* MLP-ORN 730
Scolopacidae: *Gallinago paraguaiae* MLP-ORN 731; *Tringa solitaria* MLP-ORN 2087; *Tringa flavipes* MLP-ORN 1865
Stercoraridae: *Stercorarius maccormicki* MLP-ORN 1847
Laridae: *Sterna vittata* MLP-ORN 2161; *Sterna hirundo* USNM 553303; *Chroicocephalus cirrocephalus* MLP-ORN 2177; *Chroicocephalus maculipennis* MLP-ORN 2178; *Leucophaeus scoresbii* MLP-ORN 562; *Larus dominicanus* MLP-ORN 2176

Gaviiformes
Gaviidae: *Gavia immer* USNM 502462

Sphenisciformes
Spheniscidae: *Pygoscelis adeliae* MLP-ORN 1134

Procellariiformes
†Diomedeoididae: *Rupelornis definitus* IRSNB Av 109l
Diomedeidae: *Thalassarche melanophris* MLP-ORN 1624
Oceanitidae: *Oceanites oceanicus* MLP-ORN 1905
Hydrobatidae: *Oceanodroma leucorhoa* USNM 614217
Procellariidae: *Ardenna grisea* MLP-ORN 609; *Macronectes giganteus* MLP-ORN 1592; *Calonectris edwardsi* USNM 560766; *Calonectris leucomelas* USNM 559033; *Pelecanoides urinatrix* USNM 553143; *Ardenna carneipes* USNM 621658; *Ardenna creatopus* USNM 559556; *Ardenna gravis* USNM 614345; *Ardenna grisea* USNM 556462; *Puffinus lherminieri* USNM 488402; *Puffinus nativitatis* USNM 613922; *Puffinus puffinus* USNM 610341

Suliformes
Phalacrocoracidae: *Nannopterum brasilianum* MLP-ORN 983

Strigiformes
Tytonidae: *Tyto furcata* MLP-ORN 2048
Strigidae: *Asio otus* MLP-ORN 541

Accipitriformes
Accipitridae: *Buteo magnirostris* MLP-ORN 362

Cariamiformes
†Phorusrhacidae: *Psilopterus lemoinei* AMNH 9257

Falconiformes
Falconidae: *Caracara plancus* MLP-ORN 2325
Milvago chimango MLP-ORN 2292; *Falco sparverius* MLP-ORN 2336; *Falco femoralis* MLP-ORN 2335; *Falco tinnunculus* MLP-ORN 1237

†Odontopterygiformes
Pelagornithidae: *Pelagornis* sp. LACM 128424; *Pelagornis chilensis* MNHN SGO.PV 1061