

The Collection of Type Fossils of the Natural Science Museum of the University of Zaragoza (Spain)

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Abstract The Natural Science Museum of the University of Zaragoza houses one of the most important collections in Spain of fossils published in scientific journals. It is a new museum, which has brought together the fossil collections of the Palaeontological Museum of the University of Zaragoza with the university's historical collections. It harbours 33,561 fossils, which have been studied in 524 scientific publications (dissertations, books and journals), and of which 243 are holotypes. All the material is inventoried in a FileMaker database and is available for consultation by any researcher who applies to do so. The type fossil collection is mainly from the Autonomous Region of Aragón in Spain (comprising the provinces of Zaragoza, Huesca and Teruel), with a small proportion from other Spanish regions (less than 10%) and from other countries (less than 1%). The collection is diverse on what concerns taxonomic groups, with arthropods, brachiopods, echinoderms and vertebrates standing out in terms of the number of specimens and of holotypes. The fossils date from the Upper Proterozoic to the Pleistocene, the Carboniferous-Triassic being the least-represented period. Particularly noteworthy are the collections of invertebrates from the Cambrian and of mammals from the Aragonian (Tertiary).

Keywords Fossils · Zaragoza University Museum · Spain · Collection management

Introduction

Fossils are a fundamental component of the geodiversity of Earth. As such, they require the tools of management and preservation; in many cases, they shared with other elements of geodiversity as with the storage of collections in museums, especially if the specimens in question are of special scientific interest or heritage value. There are certain types of fossil that can be preserved 'in situ', such as the silicified trunks of large trees or the tracksites of vertebrates. In such cases, it is common for them to be used for geotourism, entailing the provision of the requisite structures for their preservation and exhibition. There are many examples of this in Spain; one of the most notable of which is the dinosaur tracksite of Las Cerradicas in Galve, Teruel (Castanera et al. 2011). The high amount of outcrops with tracksites in some areas makes it difficult to decide which sites to choose for protection and exhibition. Such decisions require a correct assessment of the sites with a methodology that takes into account a range of scientific, heritage-related and cultural aspects (García et al. 2014). A different approach is needed for fossils extracted from rocks, which tend not to need field strategies for their protection. The function of storing and preserving the palaeontological heritage is in this case assumed by museums. Furthermore, most scientific publishers require that the fossils cited in their journals should be housed in a public museum. The aim of this requirement is double: on the one hand, it ensures that the material is accessible to other researchers in the future; on the other hand, it guarantees that there are suitable conditions for preserving the geological heritage in question.

The University of Zaragoza (Aragón, Spain) is one of the oldest universities in Spain, dating back to 1542. It has an extensive tradition in the research and teaching of the natural sciences; as a consequence of which, it harbours collections of great historical, scientific and cultural interest. With the idea of

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protecting these and bringing them to the public attention, on 24 June, 2013, the Government Council of Aragón unanimously agreed to create the Natural Science Museum of the University of Zaragoza as ‘a structure of a stable nature dedicated to the cataloguing, investigation, preservation, restoration, exhibition, dissemination and growth of the heritage relating to the natural sciences of the University of Zaragoza, pursuing the aims of study, education and recreation.’ The permanent exhibition, inaugurated in the building of the Paraninfo in the university in December 2015, displays a wide representation of the specimens kept in the museum. Outstanding among these is the broad and diverse collection of fossils, as well as other elements of natural heritage (Canudo 2015). As a university museum, moreover, it holds an interesting and unique collection of fossils published in scientific journals. The aim of the present article is to draw attention to the palaeontological heritage housed in the Natural Science Museum of the University, paying a particular attention the material referenced in scientific publications that is kept in the type collection of the museum.

Fossil Collection of the University of Zaragoza

The fossil collection of the Natural Science Museum of the University of Zaragoza is derived from three main sources: the historical collection of the University of Zaragoza, the collection of the Palaeontological Museum and the Longinos Navás Collection. Below, we shall briefly look at the history of these three collections.

Historical Collection

On 14 August 1783, the Aragonese Economic Society of Friends of the Country founded the Natural History Office, and this can be considered the birth of natural science studies in the city of Zaragoza (Laguía 1990). The members of the society were highly active in the collection of geological objects such as minerals from Aragonese sites, leading to the formation of a first collection, now of apparently unknown elements, at least as a whole. Some authors trace its destruction-disappearance to the Peninsular War in the early nineteenth century (Calvo 2014). There are no references in the current historical collection to specimens gathered in the eighteenth or early nineteenth century. In the course of the nineteenth century, the activity of the professors of natural sciences at the University of Zaragoza again led to the accumulation of a significant geological collection (Laguía 1990). This subsequently grew substantially at the end of the nineteenth century, when the Commission for the Geological Map of Spain (currently known as the Geological and Mining Institute of Spain) donated a collection of minerals gathered and classified by Joaquín Gonzalo y Tarin, another collection

of rocks prepared by Pedro Palacios, and a third collection of fossils gathered by Florentino Azpeitia. Most of the historical minerals belonging to the University of Zaragoza (UZ) were the result of a donation made by the Commission for the Geological Map of Spain in 1893, mainly comprising Spanish specimens. The specimens from abroad in the collection thus probably date back to before this donation by the commission (Calvo 2014). These collections of minerals, together with the fossil collections from Father Bataller, Eduardo Alastrué and the *Comptoir Mineralogique et Geologique Suisse*, led initially to the creation of the Regional Geological Museum, dependent on the Chair of Geology. This subsequently changed its name to the Geological Museum of the Faculty of Sciences when it acquired the collection of Oriol Riba (Laguía 1990). The introduction of the studies of geology at the University of Zaragoza in 1974 resulted in the geological collection being divided up, with minerals, rocks and fossils going to different departments within the newly created Section of Geology. The fossils from this historical collection formed the nucleus of the collection of the Palaeontological Museum of the University of Zaragoza.

The Collection of the Palaeontological Museum of the University of Zaragoza

The fossil collection of the Palaeontological Museum is one of the foundational collections of the Natural Science Museum and possibly the most important one from the point of view of science and heritage. The historical fossil collection of the University of Zaragoza housed in the Faculty of Sciences was the springboard upon which the University Department of Palaeontology—with the support of the academic authorities and the Government of Aragón—opened the permanent exhibition known as the Palaeontological Museum of the University of Zaragoza. The exhibition hall in the building of geology was named after Lucas Mallada, in homage to the Aragonese naturalist. It was in operation for almost 20 years (Liñán 2009a, b).

The fossil collection of the Palaeontological Museum grew significantly at the close of the twentieth century due to a number of factors. These include the introduction of geology studies in the University of Zaragoza, with the resulting appointment of palaeontology teachers who from now on pursued their research in Aragón and deposited their collections in the museum. Moreover, in the 1980s, the Regional Government of Aragón passed a law of cultural heritage decreeing that fossils formed part of the Aragonese cultural heritage. One of the consequences of this was that palaeontological material collected in Aragón had to be deposited in the only palaeontology museum in existence in the region, which was the Palaeontological Museum of the University of Zaragoza. Accordingly, the research activities both of palaeontologists from the University of Zaragoza and of other researchers that have worked in this

part of Spain have led to the exponential growth of the collection.

In addition to the more ordinary items, mention should also be made of the extraordinary fossils that have joined the collection. The palaeontology professors of the University of Zaragoza have carried out an enormous amount of work in recovering specimens extracted by foreign researchers in different parts of the Autonomous Region of Aragón from the 1950s onwards, specimens that were not deposited in other European museums at the time. These are mainly fossils from the Palaeozoic Era, which formed part of PhD theses or fieldwork prior to the introduction of regional legislation on the palaeontological heritage; examples are the collections of German professors Carls or Hammann (Carls 1986; Hammann 1992). The museum has further received donations from amateurs, most of which are specimens with no scientific interest but that are nonetheless of great public interest and of course of huge value as part of the palaeontological heritage. As will be described below, at present, there is a detailed inventory only of the material in the type-specimen collections; there is no complete inventory of the fossil collection of the museum. A conservative estimate would put it at more than 90,000 specimens.

Longinos Navás Collection

The naturalist Longinos Navás (Cabacés, 1858–Girona, 1938) was a Jesuit priest and teacher of natural history for more than 40 years at the school of ‘El Salvador’ in Zaragoza. He was also one of the driving forces behind the Iberian Society of Natural Sciences. His collection of objects of natural science comprised specimens gathered in different parts of the world by Jesuit priests, as well as others resulting from his own activity as an entomologist (Bastero Monserrat 1989). The part of his collection that was kept in the school of ‘El Salvador’ in Zaragoza was deposited to the University of Zaragoza in 1988 with the aim of ensuring its preservation and bringing it to the public attention. The current Navás Collection consists of thousands of naturalized specimens, skeletons, molluscs and insects, as well as a small geological collection. Outstanding within this collection are various fossil holotypes (Bastero Monserrat 1989) and some minerals. The oldest holotypes housed in the museum are those from the Navás Collection, such as *Pelophylax pueyoi* (Navas 1922), initially described as *Rana pueyoi* (Fig. 1).

The Type Collection of the Museum

In recent years, most scientific palaeontology journals have included in their conditions for publication the stipulation that the fossils under study should be housed in a recognized, publicly owned museum. The reason for this is to guarantee



Fig. 1 Holotype of *Pelophylax pueyoi* (Navas 1922): MPZ 94/1052 (LN-00416) is one of the oldest holotypes in the collection of the Natural Science Museum of the University of Zaragoza

access for any researcher to the published fossils, thus reducing to a minimum the possibility of fraud. It is also a way of ensuring the adequate preservation of the scientific and palaeontological heritage. The Museum of Natural Sciences of the University of Zaragoza keeps those specimens that have been published in scientific journals in a separate space referred to as the type collection (Gámez Vintaned et al. 2012). Some fossils of type collection with particular value as exhibits are on display in the museum’s permanent exhibition, such as the holotype of the crocodylomorph *Maledictosuchus riclaensis* (Parrilla-Bel et al. 2013). The specimens belonging to the type collection are kept in fire-proof cupboards. Each specimen is individually identified and provided with an inventory number (for example MPZ-95/2366) with which it has been referenced in the scientific journal. The acronym MPZ started to be used in the Palaeontological Museum, so when its collections came to form part of the Museum of Natural Sciences of the University of Zaragoza, it was considered advisable to keep this same acronym for the sake of nomenclatural stability. Initially, correlative numeration was used (MPZ-1, 2...), but as a result of the great volume of specimens, this was changed in the year 2000 to a number composed of the year and the correlative number for that year (MPZ 2016/364), which is the current numeration. The fossils of the type collection are arranged by scientific publication, so all the specimens studied in a particular scientific paper are kept together. This

arrangement is intended to make the work of the researchers easier facilitate the work of the researchers seeking to consult the museum collections.

All the fossils of the type collection are included in a database managed by the application FileMaker. The database has more than 30 fields, granting access to information on the name of specimen, publication, site of origin, age, etc., as well as considerations of heritage and location (Fig. 2). The database allows cross-searches, making it possible to find out the number of specimens from a particular site or of a particular age. The material kept in the in the type specimen collections has been published in 524 scientific papers (journals, dissertations, book chapters and conference papers). Almost a third of these publications correspond to journals included in the most important quality index databases such as the Science Citation Index or Scopus.

As of October 2016, the type specimen collection holds houses 34,046 fossils; 89% of which are from Aragón (the provinces of Zaragoza, Huesca and Teruel), and 11% of which were gathered elsewhere in Spain or in other countries (Fig. 3a). Arranged by taxonomic group, there is a majority of vertebrates (43%) due to the abundant Pleistocene

collection. Arthropods (29%) and molluscs (14%) also have notable representations. The other groups of fossil remains have representations lower than 5%, including a collection of ichnofossils (2%). There are also fossils such as the foraminifera, which are represented by thousands of specimens, but only the figured material has been included in order to avoid distorting the proportions of the different groups (Fig. 3b). If the type specimen collection specimens are considered in terms of age, they can be seen to range from the Upper Pre-Cambrian to the present (Fig. 3c). The Cambrian and the Quaternary are the periods with the greatest quantity of specimens in the type specimen collection (20%), but there are also significant proportions of specimens from the Devonian, the Jurassic and the Cretaceous (more than 10%). The other periods have representations of less than 10%. Particularly noteworthy is the relatively low number of fossils from the Pre-Cambrian, the Carboniferous, the Permian and the Triassic, with less than 1%.

Number 1 in the collection (MPZ 01) is the pygidium of a trilobite arthropod. This belongs to the holotype of *Paralejurus carlsi*, from the Mariposas Formation, dating from the Emsian (Lower Devonian) of Nogueras, Zaragoza. This specimen was published almost 20 years after being

Fig. 2 Index card for MPZ 01: this is the first number in the collection of type fossils of the Natural Science Museum of the University of Zaragoza. The card shows the information for the holotype of *Paralejurus carlsi* Schraut and Feist 2004, which is included in the database of collection of type fossils

MPZ: 01	Taxón Paralejurus carlsi
Otras siglas	Autor Schraut & Feist Año 2004
Filo o División Arthropoda	Publ. 1 Schraut, G., Feist, R. 2004. The Devonian Styginid trilobite <i>Paralejurus</i> , with new data from Spain and Morocco. Journal of Paleontology 78(4), 709-722.
Clase Trilobita	Nº Publ. 1 307
Orden Corynexochida	Pág. descr. Publ. 1
Familia Styginidae	Láminas, Figuras Fig. 6.9-6.11
Parataxones	Estatus Holotipo
Titularidad UZ	Descripción Pigidio. Pygidium semielliptic, bell-shaped in transverse section with slightly upturned margins. Prominent axis short (sag.), subpentagonal in outline, wider anteriorly than
Situación Tipoteca	Nº otras Publ.
Problemas Autor	Eratema Paleozoico Sistema Devónico
Autor y Año Schraut & Feist, 2004	Serie Devónico Inferior Piso/Subp. Emsiense inferior
Ficha modif. por Autor:	Litología Grupo
Enviar Modificaciones	Formación Mariposas Miembro
Instrucciones para el envío	Biozona
	Provincia Teruel
	País España Área Geográfica Sistema Ibérico
	Añadir comentarios de autor [opcional]

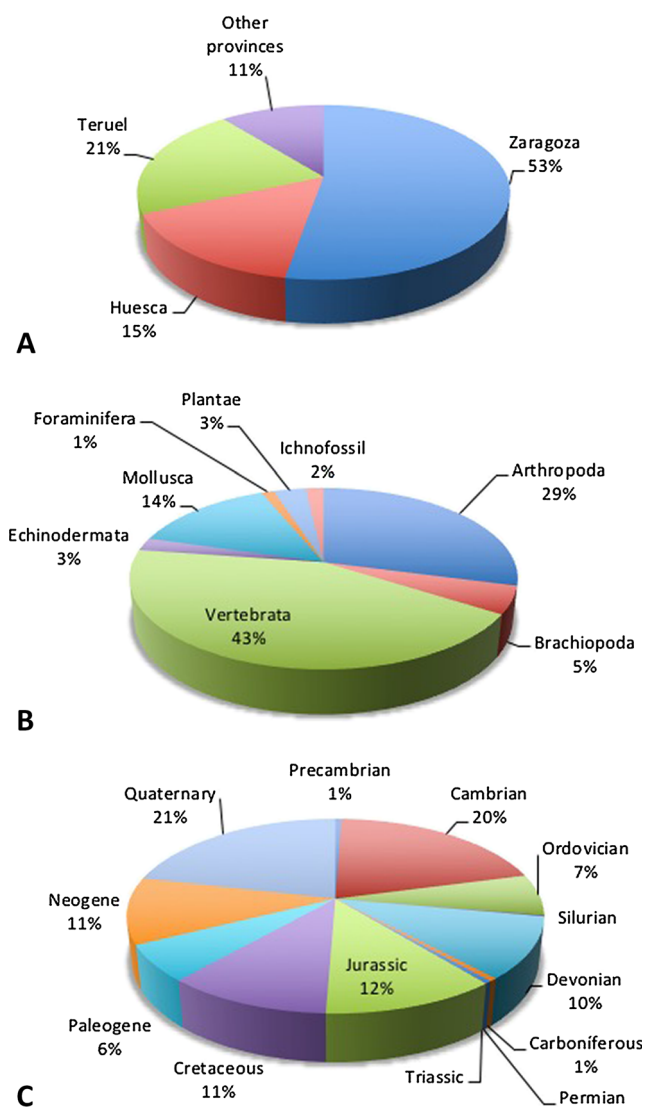


Fig. 3 The total number of specimens in the collection of type fossils of the Natural Science Museum of the University of Zaragoza, distributed by **a** Spanish provinces: the specimens from outside Spain represent less than 1% of the collection; **b** taxonomic groups: ichnofossils have been included as a separate group; and **c** time periods: the fossils of the Triassic, Permian and Silurian represent less than 1% of the collection

given its number (Schraut and Feist 2004). The oldest holotype is from the ‘Collection of Longinos Navás.’ This is a large slab with the holotype of *Chirosaurus ibericus* Navas 1906 from the Triassic of the Moncayo, Zaragoza. This has recently been assigned to *Chirotherium barthii*, so it could be a junior synonym (Díaz-Martínez et al. 2015).

The type specimen collection of the museum is composed of invertebrate and vertebrate ichnofossils (Gámez Vintaned et al. 2006; Navarrete et al. 2014), eggshells from Cretaceous archosaurs (Moreno et al. 2014), outstandingly preserved specimens such as insects from the Miocene (Peñalver et al. 2013), invertebrate fossils (Meléndez and Fontana 1991; Dies Álvarez et al. 2013; Delvene et al.

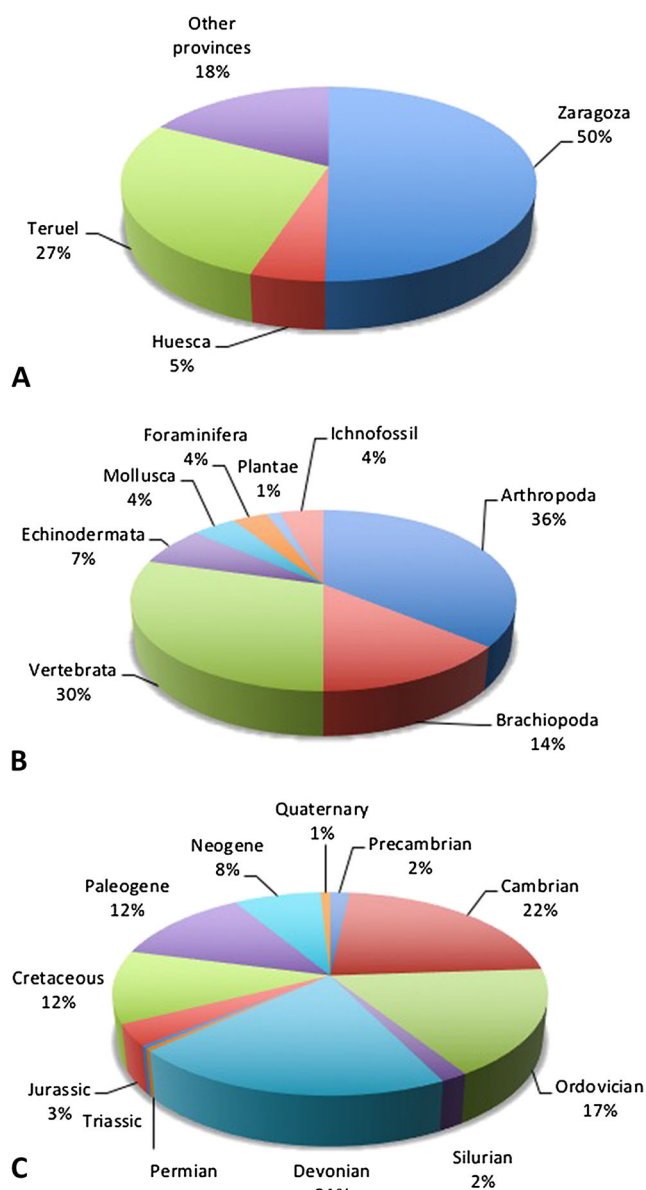


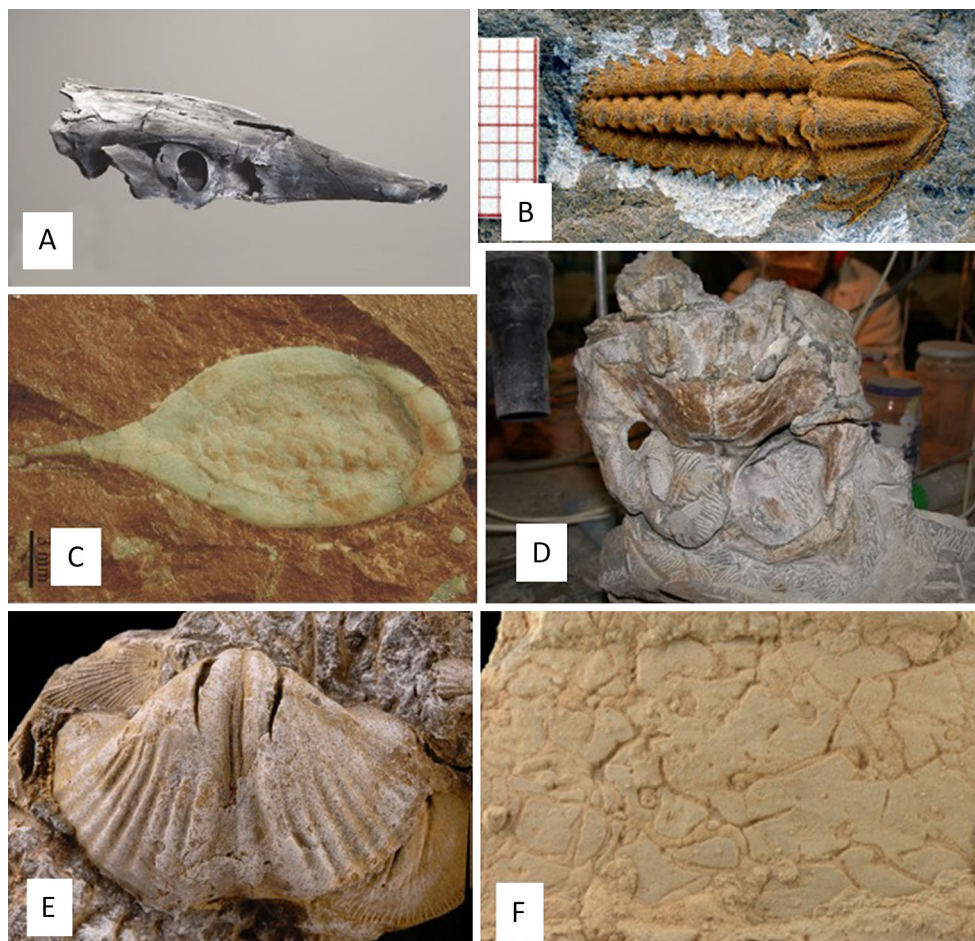
Fig. 4 Holotypes in the Tipoteca of the Natural Science Museum of the University of Zaragoza, distributed by **a** Spanish provinces: the specimens from outside Spain represent less than 1% of the collection; **b** taxonomic groups: ichnofossils have been included as a separate group; and **c** time periods: the fossils of the Triassic and Permian represent less than 1% of the holotypes in the Tipoteca. There is no holotype from the Carboniferous in the Museum collection

2011), microfossils such as foraminifera and ostracods (Canudo 1997; Arenillas et al. 2016; Gozalo and Hinz-Schallreuter 2002), vertebrate bones and teeth (Azaña et al. 1993; Company et al. 2015), and plant leaves and cuticles (Sender et al. 2008; Moreno-Domínguez et al. 2016). Given the diversity of the material, the importance of the individual items is difficult to quantify, but among them, there are collections of undoubted worldwide importance that have been published in highly prestigious journals. Particularly noteworthy are the ichnofossils from

the Pre-Cambrian and Lower Cambrian (Gámez-Vintaned 1995); the Cambrian invertebrates from the south of Province of Zaragoza (Murero, Ateca, Purujosa), which include trilobites, echinoderms and soft-bodied organisms (Liñán and Gozalo 1986; Zamora et al. 2009; Esteve et al. 2010; Dies Álvarez et al. 2013); the ammonoid cephalopods from the Jurassic from the provinces of Teruel and Zaragoza (Meléndez 1989); the mammals from the Barremian of the Iberian Range (Canudo and Cuenca 1996; Badiola et al. 2008; Cuenca-Bescós et al. 2011); the plants from the Lower Cretaceous of the Escucha Formation in Teruel (Sender et al. 2008); the dinosaurs from the north of the province of Huesca (Arén), with a unique collection from the upper Maastrichtian (Cruzado-Caballero et al. 2013; Canudo et al. 2016); and the mammals from the Aragonian (Miocene) recovered from different outcrops in the province of Zaragoza (Azanza et al. 1998; Astibia et al. 1998). Also outstanding are the exceptionally well-preserved vertebrates, insects and plants from the Miocene of Rubielos de Mora and Libros in Teruel (Peñalver et al. 2013) and the collection of cave bears from the Pleistocene of Huesca (Rabal-Garcés et al. 2012).

The type-specimen collection of the museum houses 213 holotypes (Fig. 4), 82% of which are from the region of Aragón, with 18% from the rest of Spain or from other countries. As such, the type-specimen collection harbours a collection that has mainly been gathered in Aragón, although this does not mean that most of the holotypes of the species described in Aragón are housed in the museum. In fact, the Natural Science Museum of the University of Zaragoza contains between just 15 and 20% of the taxa described in this region of Spain (Fig. 5a). Unfortunately, a substantial portion of the Aragonese holotypes, in particular those of fossil species described in the nineteenth and early twentieth century, has gone astray (Forner i Valls 2010). There are also holotypes that have the museum's acronym MPZ, but for bureaucratic reasons, are not currently in the type-specimen collection. This is the case with the sauropod dinosaur *Tastavinsaurus sanzi* (MPZ 99/9). This was initially deposited in the museum (Canudo et al. 2008), but following an administrative decision by the regional government, it was subsequently moved to the Dinópolis Palaeontological Museum of Teruel.

Fig. 5 Some of the holotypes in the Tipoteca collection of the Natural Science Museum of the University of Zaragoza. **a** *Carolowilhelmia geognostica* Carls 1995 (MPZ 97/74) from the Middle Devonian of Monforte de Moyuela (Teruel). **b** *Sdzuyia sanmamesi* Liñán and Gozalo 1999 (MPZ 2000/2) from the Lower Cambrian of Murero (Zaragoza). **c** *Protocinctus mansillaensis* Rahman and Zamora 2009 (MPZ 2004/170) from the Middle Cambrian of Purujosa (Zaragoza). **d** *Arenysaurus ardevoli* Pereda Suberbiola et al. 2009 (MPZ 2008/1) from the upper Maastrichtian of Arén (Huesca). **e** *Vandercammenina sollei* Carls 1986 (MPZ-102) from the Lower Devonian of Santa Cruz de Nogueras (Teruel). **f** *Labyrinthichnus terrerensis* Uchman and Alvaro 2000 (MPZ-17136) from the Miocene of Terrer (Zaragoza). Photos: **a**: Gonzalo Bullón; **b**, **c** and **f**: Isabel Pérez Urresti; and **e**: Zarela Herrera



The percentage distribution of holotypes by age and group is rather different than if we consider the specimens as a whole. There is a significant and diverse representation of holotypes of different groups of organisms, including ‘algae,’ protists, plants, invertebrates and vertebrates, from all ages from the Pre-Cambrian to the Pleistocene. However, there are some groups and ages that are better represented than others. Accordingly, 36% of the holotypes are of arthropods (Fig. 5b), with a good representation of vertebrates (30%) and brachiopods (14%). The remaining groups represent less than 10%. Plants and molluscs, well represented in the museum collection, nonetheless have only a small number of holotypes of species deposited. As far as age is concerned, there is a majority of specimens from the Palaeozoic, especially from the Cambrian, Ordovician and Devonian (Fig. 5c). By contrast, there are other intervals with few or no holotypes, such as the Pre-Cambrian, the Silurian, the Carboniferous, the Permian, the Triassic and the Quaternary. The latter period is particularly significant because it is one of the time intervals with the greatest number of specimens in the type-specimen collection of the museum.

Conclusions

The specimens housed in the collection of type fossils of the Natural Science Museum of the University of Zaragoza is one of the most important palaeontological collections in Spain in terms of the number of specimens published in scientific journals (34,046) and the number of holotypes that are held in it (243). This material has been published in 524 scientific papers, including PhD dissertations, articles in scientific journals, book chapters and conference papers.

A large part of collection has been gathered in the region of Aragón, although there are minor representations from other parts of Spain, from southern Europe and northern Africa. The collection contains specimens from practically all major groups of vertebrates (mammals and archosaurs), invertebrates (arthropods, molluscs and echinoderms), foraminifera, plants, ichnofossils of vertebrates and invertebrates, and eggshells. On what concerns the age of the specimens, there is a representation of fossils ranging from the Upper Neoproterozoic to the Quaternary, with the collection of Palaeozoic holotypes being particularly noteworthy. The least-represented interval (less than 1%) is the Carboniferous-Triassic. Access to consultation of the material of the type collection is open to any researcher on written application. The general public only has access to the holotypes specimens that are on display in the permanent exhibition.

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