

From the Field to the Museum: Analysis of Groups-Purposes-Locations in Relation to Spain's Moveable Palaeontological Heritage

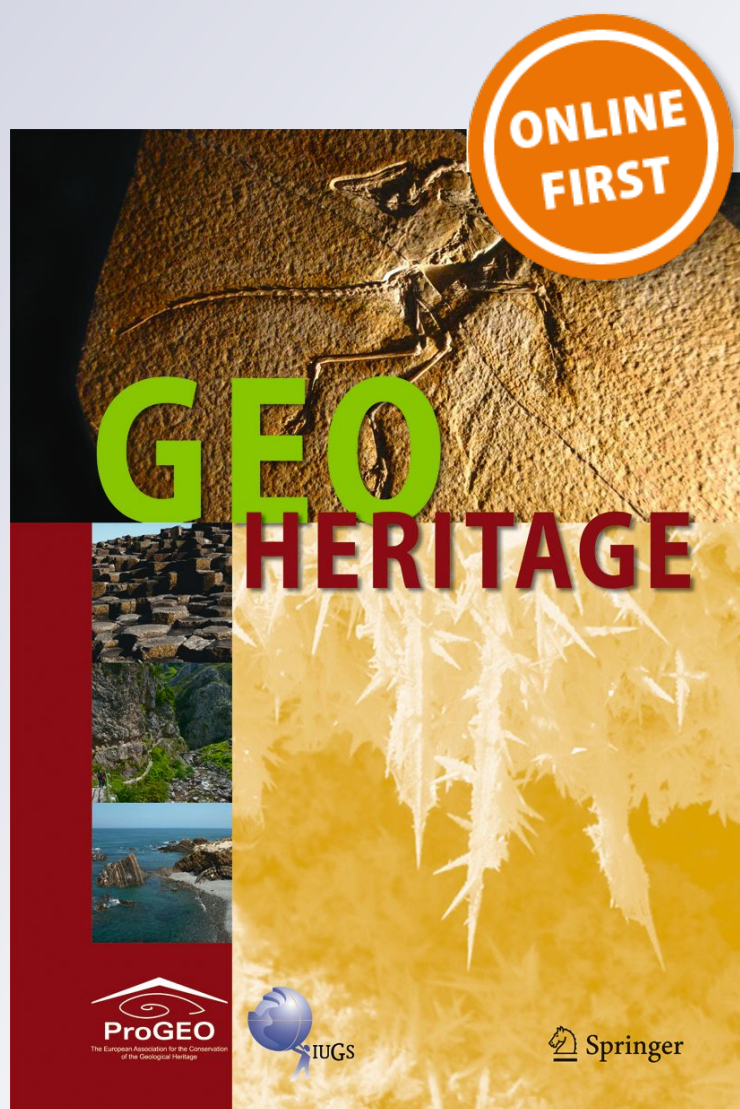
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From the Field to the Museum: Analysis of Groups-Purposes-Locations in Relation to Spain's Moveable Palaeontological Heritage

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Abstract

This paper analyses the problems surrounding Spain's moveable palaeontological heritage, the definition thereof, the national and regional legislation which governs it, and the particular features involved in keeping track of fossils from their natural geological context to their temporary or permanent storage or exhibition. Collecting pressures are created by five groups: (1) scientists, (2) amateurs, (3) collectors, (4) dealers and (5) civil engineering/mining. Each group can produce different pressures and impacts on a palaeontological site, but these pressures must be considered in the context of the sensitivity of a particular site in order to achieve sustainable management. This article offers recommendations for the trading and collecting of fossils which comply with the regulations and encourages greater social awareness of the importance of education and ethical principles when it comes to preserving and enjoying the moveable palaeontological heritage of other countries. Finally, it proposes a code of ethics for regulating fossil collecting in Spain.

Keywords Moveable palaeontological heritage · Possession · Regulation · Trading · Spain

Introduction

Moveable geological heritage can be defined as “non-renewable geological elements extracted from their context and with a value (scientific, didactic, and/or aesthetic) that makes them a collective patrimonial asset that must be preserved for the

benefit of the whole society” (Díaz-Martínez et al. 2012). Moveable palaeontological heritage has unique features which make it a special case within the context of geoheritage in terms of possession, conservation, use and legal protection (Page 2003; Díaz-Martínez et al. 2012, 2016; Percival 2014; Henriques and Pena dos Reis 2015; Delvene et al. 2016; Vegas et al. 2017). The scientific community was charged with preserving palaeontological resources for present and future generations because these resources are non-renewable and are an irreplaceable part of nature's heritage. The vital role of specialised geological museums in the active protection of moveable palaeontological heritage is indisputable (Jakubowski 2004). However, experts are aware that irrational collecting, and especially illicit and uncontrolled trade, together with vandalism, are the main problems faced by palaeontological heritage which is, at the end of the day, moveable geological heritage (Edmonds and Larwood 2005).

This is due to two main factors: (i) the lack of specific legislation to govern these practices and a lack of penalties to punish crimes against the geoheritage, and (ii) a profound disregard on the part of society for the value of the geoheritage, in general, and of our moveable palaeontological heritage, in particular. However, we agree that a total ban on the collection of fossils is not the only way forward for geoconservation. Organised activities could be carried out at those sites which

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offer abundant *ex situ* fossils, as long as their scientific interest is previously assessed by palaeontological researchers. The difficulty lies in finding a fair middle ground which does not endanger palaeontological heritage but permits traditional and educational activity which promotes vocations and geo-conservationist sensitivities and sentiments. Recently, Page et al. (2017) also determine that collecting fossils, appropriately, can promote scientific discoveries and educational benefits.

Background and Rationale

This research paper is written in the context of the Spanish Government's Natural Heritage and Biodiversity Strategic Plan (2011–2017) or PEPNB (its initials in Spanish) that is the one of Royal Decrees for the development of the Law 42/2007 for Natural Heritage and Biodiversity. The Spanish Ministry of Agriculture and Fisheries, Food and the Environment designated the IGME (Spanish Geological and Mining Institute) as the public body responsible for the "Spanish National Inventory of Geological Heritage" and charged the IGME directly with analysing the main objective of "promoting mechanisms to regulate the collection of, and control national trading in, moveable geological heritage". The mechanisms established by the PEPNB will contribute to the protection, preservation, study and promotion of, training in, and transmission to future generations of Spain's geoheritage and the assets that form part of it, whatever their legal status and ownership, thereby guaranteeing their use as a social benefit and a key factor of sustainable development.

This present work analyses legislation and policies in Spain related to palaeontological heritage at national and regional scales. A SWOT analysis differentiates between collection, possession and trading by different groups, and proposes a series of recommendations for regulating the collecting and trading of fossils, which constitute moveable palaeontological heritage, to ensure their better management and protection.

Current Situation in Spain

National and Regional Legislation

Spain's palaeontological heritage is governed by two separate laws, and the protection thereof is subject to two separate administrations. For decades, this situation has created serious problems and conflicts of interest due to the undesired subordination of palaeontological heritage to historical, cultural, and archaeological heritage.

A review of national legislation governing fossils and the protection thereof involves two different sets of regulations: (i) Law 33/2015, which amends Law 42/2007, on Natural Heritage and Biodiversity emanating from the ministry with

competence for the Environment, and (ii) Law 16/1985 governing Spain's historical heritage, emanating from the ministry with competence for the country's historical and cultural heritage. This Law covers fossils as special cases by means of a vague, ill-defined position regarding cultural heritage. Thus, Spain's palaeontological heritage was originally governed by national cultural laws.

This dual approach to the protection of fossils in Spanish national legislation gives rise to situations which are difficult to manage from a scientific and legal point of view. This is a conceptual error in spite of the fact that fossils are valuable natural elements and not human made (e.g. Carcavilla et al. 2009; Díaz-Martínez et al. 2013).

As natural heritage legislation, historical heritage management depends on Autonomous regions, according to the 1978 Spanish Constitution (Art. 148.1.16°) and the Constitutional Court's ruling 17/1991 (RTC 1991/17). Citing Law 16/1985, which governs Spain's historical heritage, the ruling stated that "the geological and palaeontological elements related to the history of humans and their origins and antecedents also form part of this [historical] heritage". Thus, when this legislation was transposed into the legislation of the autonomous regions which governs historical heritage, it also included fossils, despite these being geological elements of natural origin (Tables 1 and 2). In this way, a number of major fossil sites and their moveable heritage had to be legally protected as "historical sites" or "archaeological zones" (e.g. in 2013, the Palaeontological Site of Puerto de la Cadena was declared a "Site of Cultural Interest: Palaeontological Zone" by the Autonomous Region of Murcia). In all regional and national legislation, the palaeontological heritage is considered as part of the geological heritage, and it is included in the Historical and/or Cultural Heritage in every Autonomous Region except Navarra in which it is not considered and the Basque Country, in which it is considered as part of the archaeological heritage.

SWOT Analysis

The methodology used for SWOT analysis is based on the selection on a highly specialised and expertized team for carrying on. The working group covers the main aspects related to the moveable geological heritage which comprises a curator on palaeontology collections, a curator on mineralogy and rock collections, a researcher on palaeontology, a head of a geological heritage department and a head of a geological museum. The selected topics to analyse are recollection, possession and trading. Therefore, the threats, opportunities, weaknesses and strengths are evaluated separately by each member of the working group, and for the next kinds of moveable geoheritage: (1) Palaeontological (fossil invertebrates,

Table 1 Regional legislation and palaeontological protection figures related to historical or cultural heritage. *HC* Historical Complex (= *CH* Conjunto Histórico), *HP* Historical Place (= *LH* Lugar Histórico), *M* Monument (= *M* Monumento), *HS* Historical Site (= *SH* Sitio Histórico), *AZ* Archaeological Zone (= *ZA* Zona Arqueológica), *SCi* Site of Cultural Interest (= *BIC* Bien de Interés Cultural), *ZPi* Zone of Palaeontological interest (= *ZiP* Zona de Interés Paleontológico), *PZ* Palaeontological Zone (= *ZP* Zona Paleontológica), *HZ* Heritage zone (= *ZPt* Zona Patrimonial)

Autonomous community/city	Legislation related to the historical or cultural heritage, with palaeontological implications	Palaeontological protection figures
Andalucía	- Law 14/2007, of 26 November 2007. Historical Heritage Law of Andalucía - Decree 379/2009, of 1 December, modified of Decree 4/1993, of 26 January: approval of regulation of Administrative Organization of Historical Heritage of Andalucía; and Decree 168/2003, of 17 January: approval of Regulation of Archaeological Activities	M, CH, SH, ZA, ZPt M, HC, HS, AZ, HZ
Aragón	- Law 3/1999, of 10 March. Cultural Heritage Law	ZP PZ
Asturias	- Law 1/2001, of 6 March. Regulation rules of Cultural Heritage	SH, ZA HS, AZ
Canarias	- Law 4/1999, of 15 March 1999. Historical Heritage Law of Canarias - Decree 262/2003, of 23 September. Approval of regulation of archaeological interventions of Autonomous Community of Canarias	SH, ZP HS, PZ
Cantabria	- Law 11/1998, of 13 October. Cultural Heritage Law - Decree 36/2001, of 2 May. Partial development of Cultural Heritage Cantabria Law 11/1998, of 13 October 1998	M M
Castilla-La Mancha	- Law 4/2013, of 16 May. Cultural Heritage of Castilla-La Mancha	ZP PZ
Castilla-León	- Law 12/2002, of 11 July. Cultural Heritage Law of Castilla y León	SH HS
Cataluña	- Law 9/1993, of 30 September. Regulation of cultural heritage - Decree 78/2002, of 5 March. Regulation of archaeological and palaeontological heritage protection - Decree 328/2011, of 26 April. Establishment of National Archaeology and Palaeontology Council, and Archaeology and Palaeontology research commission	ZP PZ
Ceuta	No legislation	
Extremadura	- Law 2/1999, of 29 March. Historical and Cultural Heritage Law	ZP PZ
Galicia	- Law 8/1995, of 30 October. Regulation of cultural heritage of Galicia - Decree 199/1997, of 10 July. Regulation of archaeological activity	ZP PZ
Illes Balears	- Law 12/1998, of 21 December. Historical Heritage Law - Decree 144/2000, of 27 October 2000. Approval of regulation of archaeological and palaeontological interventions	ZP, LH PZ, HP
La Rioja	- Law 7/2004, of 18 October 2004. Regulation of Cultural, Historical and Artistic heritage of Autonomous Community of La Rioja	ZP, M PZ, M
Madrid	- Law 3/2013, of 18 June. Historical Heritage of Autonomous Community of Madrid	ZiP ZPi
Melilla	No legislation	
Murcia	- Law 4/2007, of 16 March 2007. Regulation of Cultural heritage of Autonomous Community of Murcia	ZP PZ
Navarra	- Foral Law 14/2007, of 4 April. Foral Law of Heritage of Navarra	Palaeontology is not considered
País Vasco	- Law 7/1990, of 3 July 1990. Regulation of Basque Cultural Heritage - Decree 341/1999, of 5 October 1999. Conditions of transfer, delivery and deposit of assets of archaeological and palaeontological interest from Autonomous Community of Basque Country	Protection figures not defined
Valencia	- Law 4/1998, of 11 June. Cultural Heritage law of Valencia	ZP PZ

microfossils, plants and fossil vertebrates), (2) Meteoritic, and (3) Mineralogical and petrological. Periodical meetings among the members of the working group, who has worked

separately, lead to the discussion of each topic and summarise in tables. The results about moveable palaeontological heritage discussion have been considered in this paper.

Table 2 Palaeontological elements from regional legislation

Autonomous community/city	Palaeontological elements from legislation
Andalucía	<i>Law 14/2007</i> : The following form part of Archaeological Heritage: moveable or immovable assets of historical interest which can be studied using archaeological methodology, whether or not they have been extracted and whether they are located above or under the ground, in inland waters or territorial waters, or on the continental shelf. Geological and palaeontological elements relating to the history of mankind and its origins and predecessors also form part of this Heritage
Aragón	<i>Law 3/1999</i> : The following form part of Aragón's Palaeontological Heritage : moveable or immovable assets which can be studied using palaeontological methodology, whether or not they have been extracted and whether they are located above or under the ground or submerged under water, and which date back to a time before the history of mankind and its origins The following form part of Aragón's Archaeological Heritage: moveable or immovable assets of a historic nature which can be studied using archaeological methodology, whether or not they have been extracted and whether they are located above or under the ground or in the water. Geological and palaeontological elements relating to the history, origins and predecessors of humanity and how humanity has evolved in the environment which it inhabited
Asturias	<i>Law 1/2001</i> : For the purposes of this Law, the following also form part of Asturias' Archaeological Heritage: objects and samples of palaeontological interest which have been separated from their natural environment or must be preserved outside of it and geological and palaeontological elements which are of interest due to their relation to the history of mankind and its origins The Government of the Principality of Asturias is empowered, by means of a Decree, to establish specific legislation which, on the basis of its specific circumstances, applies the regime which protects cultural heritage to the major areas of geological and palaeontological interest, even when the circumstances referred to in Article 1 Paragraph 3 of this present Law do not apply to them. In the same way, geological and palaeontological shall be regulated
Canarias	<i>Law 4/1999</i> : The historical heritage of the Canary Islands is made up of moveable and immovable assets of historical, architectonic, artistic, archaeological, ethnographic, palaeontological , scientific or technical interest The Archaeological Heritage of the Canary Islands is made up of moveable or immovable assets of historical interest which can be studied using archaeological methodology, whether or not they have been extracted and whether they are located above or under the ground or in territorial waters The geological and palaeontological elements related to the history of the Canary Islands, their origins and predecessors also form part of this heritage
Cantabria	<i>Law 11/1998</i> : The following form part of Cantabria's Cultural Heritage: moveable, immovable and intangible assets of historical, artistic, architectonic, palaeontological , archaeological, ethnographic, scientific and technical interest <i>Decree 36/2001</i> : The following form part of Cantabria's Moveable Heritage: those assets of historical, artistic, architectonic, palaeontological , archaeological, ethnographic, scientific or technical, documentary and bibliographical interest, related to the culture and history of Cantabria and therefore worthy of special protection and defence in order that they may be enjoyed by the citizens and that their transmission to future generations may be guaranteed <i>Article 50. Assets which make up Archaeological and Palaeontological Heritage</i> —the following form part of Cantabria's Archaeological and Palaeontological Heritage : all moveable and immovable assets and sites of historical interest, and all environmental activity related to human activity which can be researched using archaeological methodology, whether or not already discovered, whether buried or on the surface, in coastal or continental waters, including evidence of industrial and mining archaeology. Geological and palaeontological elements relating to the history of mankind and its origins and predecessors also form part of this Heritage
Castilla-La Mancha	<i>Law 4/2013</i> : The Cultural Heritage of Castilla-La Mancha is made up of moveable, immovable and intangible assets of historical, artistic, architectonic, archaeological, palaeontological , ethnographic, industrial, scientific, technical, documentary and bibliographical interest to Castilla-La Mancha Asset of cultural interest. Immovable asset— Palaeontological Heritage Site : a site containing remains, whether fossilised or not, which are a manifestation of the geological past and the evolution of life on earth, whether or not they have been extracted, whether found above or under the ground or underwater, and which are considered to be of significant heritage value
Castilla-León	<i>Law 12/2002</i> : The Cultural Heritage of Castilla-León is made up of moveable and immovable assets of artistic, historical, architectonic, palaeontological , archaeological, ethnographic, scientific or technical interest
Cataluña	<i>Law 9/1993</i> : Cataluña's cultural heritage is made up of all moveable and immovable assets related to the history and culture of Cataluña and whose historical, artistic, architectonic, archaeological, palaeontological , ethnological, documentary, bibliographical, scientific or technical value makes them worthy of special protection and defence in order that they may be enjoyed by the citizens and passed on to future generations in the best condition Catalan archaeological heritage is made up of moveable and immovable assets of a historic nature, the study of which requires the use of archaeological methodology. Geological and palaeontological elements relating to mankind and its origins and predecessors also form part of this Heritage <i>Decree 78/2002</i> : The following form part of Catalan palaeontological heritage : fossil elements not related to human beings or their origins or predecessors, and their geological context, which are situated or originate from above or under the ground, from Cataluña's inland waters or its territorial sea or the continental shelf corresponding to its coastline, or which form part of museum or other collections in Cataluña

Table 2 (continued)

Autonomous community/city	Palaeontological elements from legislation
Ceuta	No legislation
Extremadura	<i>Law 2/1999</i> : The following make up Extremadura's Historical and Cultural Heritage: all material and intangible assets which, because they are of artistic, historical, architectonic, archaeological, palaeontological , ethnological, scientific, technical, documentary or bibliographical value, are worthy of special protection and defence Moveable and immovable assets of a historic nature which can be studied using archaeological methodology form part of Extremadura's archaeological heritage. Geological and palaeontological elements relating to mankind and its origins and predecessors also form part of this Heritage
Galicia	<i>Law 8/1995</i> : Galicia's cultural heritage is made up of moveable, immovable and intangible assets of artistic, historical, architectonic, palaeontological , archaeological, ethnographic, scientific and technical interest. The following also form part of this cultural heritage: documentary and bibliographical heritage, urban ensembles, ethnographic sites, archaeological sites and areas, and natural sites, gardens and parks which have an artistic, historical or anthropological value Galicia's archaeological heritage is made up of moveable and immovable assets of a historic nature which can be studied using archaeological methodology, whether or not they have been extracted and whether found above or under the ground or underwater. Geological and palaeontological elements relating to the history, origins and predecessors of humanity and how humanity has evolved in the environment which it inhabited
Illes Balears	<i>Law 12/1998</i> : The historical heritage of the Balearic Islands is made up of all cultural assets and values, in any of their manifestations, which are of historical, artistic, architectonic, archaeological, industrial-historical, palaeontological , ethnological, anthropological, bibliographical, documentary, scientific or technical interest to the Balearic Islands For the purposes of this law, the archaeological heritage of the Balearic Islands includes moveable and immovable assets of a historic nature which can be studied using archaeological methodology, whether or not they have been extracted and whether found above or under the ground or in territorial waters or the continental shelf. Geological and palaeontological elements relating to human history, and eco-archaeological samples dug up at archaeological sites and which should not be destroyed once they have been analysed scientifically, also form part of this heritage
La Rioja	<i>Law 7/2004</i> : The cultural, historical and artistic heritage of La Rioja is made up of all moveable or immovable assets, related to the history and culture of the Autonomous Region, and which are of historical, artistic, archaeological, palaeontological , anthropological, ethnographic, architectonic, urbanistic, natural, scientific, technical, industrial, documentary, bibliographical or audio-visual interest or value of a cultural nature
Madrid	<i>Law 3/2013</i> : The historical heritage of the Region of Madrid is made up of the tangible and intangible assets located in its territory which are considered to be of historical, artistic, architectonic, archaeological, palaeontological, landscape, ethnographic or industrial interest A palaeontological site is the geomorphological place or unit where there are fossilised remains which constitute a coherent unit in their own right and which can be studied using palaeontological methodology
Melilla	No legislation
Murcia	<i>Law 4/2007</i> : The cultural heritage of the Region of Murcia is formed by moveable, immovable and intangible assets, such as institutions, activities, practices, usages, customs, behaviour, knowledge and manifestations inherent to the traditional life which constitute significant forms of expression of the culture of the Region of Murcia which, regardless of whether it is owned publicly or privately, or of any other circumstance which affects its legal regime, deserve special protection so that they may be enjoyed by present and future generations on account of their historical, artistic, archaeological, palaeontological , ethnographic, technical or industrial value or any other value of a cultural nature ... the regional Archaeological Charter and the regional Palaeontological Charter are hereby enshrined in law...
Navarra	Navarra's Regional Law of Assets (2007) does not mention palaeontological elements
País Vasco	The Law on the Regulation of Basque Cultural Heritage (1990) does not mention palaeontological elements nor does it assign them forms of protection. It is only when it talks of excavations and finds that it links them to archaeology: "Objects and material remains of archaeological or palaeontological interest discovered by chance must be kept in the place they were found until the Provincial Council rules thereon". Or: "Archaeological excavation: the activity of investigating, documenting and unearthing or extracting archaeological and palaeontological remains with attention given to the stratigraphy of the sediments."
Valencia	<i>Law 4/1998</i> : Valencia's cultural heritage is made up of moveable and immovable assets of historical, artistic, architectonic, archaeological, palaeontological , ethnological, documentary, bibliographical, scientific, technical value or any other value of a cultural nature, existing in the territory of the Valencian Region or which, though located outside of it, are especially representative of Valencia history and culture

The collection, possession and trading of fossils which form part of the palaeontological heritage and were removed from their in situ geological context are the subjects of major debate among scientists, collectors, dealers and even

students (Jakubowski 2004; del Ramo-Jiménez and Guillén-Mondejar 2005; Edmonds and Larwood 2005; Henriques and Pena do Reis 2015). Different groups can hold strongly opposed positions, ranging from total

prohibition to complete permissiveness, and even members of the same group may disagree. Nowadays, several scientific societies express their opposition to indiscriminate collecting and defend the protection of fossils as a part of non-renewable geoheritage (e.g. ProGEO 2011; Sociedad Geológica de España 2012). Furthermore, there is a profound lack of knowledge on the part of society (the general public and even some Earth Sciences researchers, professors and teachers) about the value and significance of moveable and non-moveable palaeontological heritage.

A SWOT analysis was carried out regarding the collection, possession and trading (stores, e-commerce, auctions or local markets) of fossils (Tables 3 and 4). As a premise, we do not consider all fossils to constitute geological heritage. The statement that fossils are non-renewable scientific resources is the main justification for their protection and the reason for their being considered as part of geoheritage (Jakubowski 2004; Endere and Prado 2014; Díaz-Martínez et al. 2013). In this respect, we are going to examine the terms “collection”, “possession” and “trading” as they relate to moveable palaeontological heritage, i.e. fossils, removed

from its natural geological context and transformed into moveable heritage due to its scientific, educational and/or aesthetic value.

User Groups Related to Moveable Palaeontological Heritage

As a result of the SWOT analysis, we determined that the main problem arises in the process of fossil sampling, depending on who extracted them and for what purpose. Collecting pressures are created by different user groups as indicated by Edmonds and Larwood (2005). In Spain, we identified five main groups: scientists, casual collectors, collectors, dealers and civil engineering/mining. All of them are involved in the removal of fossils from their natural geological context and transforming them into exhibits in collections in public museums or private museums/institutions or objects for sale. Figure 1 expresses the objectives and purposes identified for each group and the final location of moveable palaeontological

Table 3 SWOT analysis of collection, possession and trading of moveable palaeontological heritage (fossil invertebrates and plants)

Moveable palaeontological heritage (micro and macrofossils: invertebrates and plants)			
External analysis		Internal analysis	
Threats	Opportunities	Weaknesses	Strengths
<i>Recollection</i>	<ul style="list-style-type: none"> - Indiscriminate plunder - Loss of geologic and taphonomic information - Depletion of fossil site 	<ul style="list-style-type: none"> - Exceptional occurrences - Adding new samples to collections of exhibitions, local and regional museums, with the aim of making them accessible and available to scientific community and general public 	<ul style="list-style-type: none"> - Recollecting in no studied fossil sites may result fatal consequences. Only experts may value the scientific importance - Collaboration between amateurs and scientists could recover exceptional preserved fossils and/or important samples from a scientific point of view - Findings are promoted because amateurs spend a great deal of time looking for fossils and know the landscapes very well
<i>Possession</i>	<ul style="list-style-type: none"> - Poor conditions on storing and caring the fossil samples - Trading and/or swapping - Use of palaeontological elements as decorative functions that can lead to speed their degradation up 	<ul style="list-style-type: none"> - The possibility that some collections or important fossils (rare, unique, in good preservation) can be guarded in optimum conditions and/or can be housed in public collections (national or regional ones) - New future sampling by experts in fossil sites discovered by amateurs 	<ul style="list-style-type: none"> - Inappropriate storing conditions (humidity, temperature) - Private use of public collections - Availability of fossils for scientific community meanwhile the access to the samples, and the storing conditions are adequate
<i>Trading</i>	<ul style="list-style-type: none"> - Exclusive economic purpose, promoting the plundering and depletion of several fossil sites - Illegal sale and irreparable damage to fossils during carving and crimping for jewellery (for instance fossils included in amber) 	<ul style="list-style-type: none"> - Possibility of finding unique, exceptional samples for museums 	<ul style="list-style-type: none"> - Difficulty of transmitting a sense of responsibility to the seller and ethics to the buyer, because of the facility for trading with fossils in fossil fairs and shows - A good regularisation of trading will allow greater control over the material that can be sold. Controlling what is traded can be more effective than banning it

Table 4 SWOT analysis of collection, possession and trading of moveable palaeontological heritage (fossil vertebrates)

Moveable palaeontological heritage (micro and macrofossil vertebrates)				
External analysis			Internal analysis	
Threat	Opportunities	Weaknesses	Strengths	
<i>Recollection</i>	- <i>Idem</i> that invertebrate fossil situation and the complication of carrying out a palaeontological digging, without experts' advice	- <i>Idem</i> that invertebrate and plant fossils situation - Fossil vertebrate finds can lead to future and successful diggings organised by experts	- <i>Idem</i> that invertebrate and plant fossils situation	- <i>Idem</i> that invertebrate and plant fossils situation
<i>Possession</i>	- <i>Idem</i> that invertebrate and plant fossils situation	- <i>Idem</i> that invertebrate and plant fossils situation - Possibility of future and successful diggings, organised by experts, in places where important samples are known from private collections	- <i>Idem</i> that invertebrate and plant fossils situation	- <i>Idem</i> that invertebrate and plant fossils situation
<i>Trading</i>	- <i>Idem</i> that invertebrate and plant fossils situation - Vertebrate fossils are less common; carrying out diggings for trading will loss geologic and taphonomic information - Deterioration of sold pieces for ornamental use	- <i>Idem</i> that invertebrate and plant fossils situation - Possibility of making replicas of fossils for future exhibitions and swapping	- <i>Idem</i> that invertebrate and plant fossils situation	- <i>Idem</i> that invertebrate and plant fossils situation

heritage, i.e. the existing situation versus the desirable and optimal situation which we recommend in this article.

Recommendations for Regulating the Collecting and Trading of Moveable Palaeontological Heritage in Spain

Recommendations Concerning the Review of Adequate Legislation of Spain

According to Díaz-Martínez et al. (2013), geoheritage forms part of natural heritage and provides support to the rest of natural heritage of a biotic character. Therefore, palaeontological heritage, which is also geological heritage, should be regulated by legislation governing natural heritage and not by legislation governing cultural heritage, as is currently the case. In any event, we recommend that geological elements (lithological formations, karst caves, etc.) governed by regional cultural heritage legislation be joined exclusively to those archaeological sites designated as natural heritage sites of cultural interest.

Recommendations for Scientists

Scientists need to collect palaeontological samples for research purposes. Spain's Autonomous Regions require that they apply for special permits for collecting fossils, always

within the academic framework of a strictly defined scientific project and in accordance with specific regional laws governing cultural and historic heritage. We recommend that these permits have to be regulated by Departments of Natural Heritage which fall under the auspices of the regional environmental authorities. Meanwhile, given the current legal situation in Spain, it would be desirable to incorporate specialists in palaeontology in all Departments of Culture which issue permits for palaeontological excavations.

Collecting fossils involves the use of scientific methodology by the research team, or students supervised by scientific staff. Fossils must be managed carefully from the moment they are collected in the field until the place of final storage. Preparing and cataloguing the samples, together with the corresponding geological and taphonomic information, are extremely important for their preservation (present and future) whether the collection from a palaeontological site is for scientific or educational purposes, especially for university degrees related to Earth Sciences. Rigorous research increases the value of a collection, especially in the case of holotypes. A holotype is a single physical sample of fossil known to have been used when the species was formally described (according to ICZN 1999). Thus, holotypes are highly valued samples held by museums and must be preserved under optimum conditions. The presence of holotypes in a palaeontological collection adds scientific and heritage value to the museums or institutions which hold them. In the case of

		MOVEABLE PALAEOLOGICAL HERITAGE			
		GROUPS	OBJECTIVES/PURPOSES	REAL LOCATION	OPTIMAL LOCATION
NON-MOVEABLE GEOLOGICAL HERITAGE Natural origin, not human made. <i>In situ</i> fossils, inside its geological context.	PERMITS	fossil sampling →			
		SCIENTISTS	- Collecting and study with research purposes and scientific methodology - Conservation of the fossils and scientific information - Educational collections for primary, secondary schools and universities	- National and regional museums and collections - Personal researching collections	- Public museums and collections which meet certain quality requirements
		AMATEURS (Casual collectors)	- Sporadic collections - Sporadic purchases - Loss of information	- Uncertain future - Temporary possession, loss of fossils	- Public museums and collections
		COLLECTORS (Collecting fossils as a recreational pursuit)	- Collecting without scientific methodology (loss of taphonomic information) - Conservation and safe-guard of fossils - Trading (buying and/or selling) - Swapping	- Private collections - Temporary possession - Donation to museums - Total or partial trading - Private and local museums and/or exhibitions	- Public museums and collections
		DEALERS (Commercial exploitation of fossils)	- Collecting and trading, without scientific methodology - Conservation of the fossils - Trading with economical purposes	- Private collections	- Public museums and collections - Regulated trade with clear rules according to countries where fossil trading is allowed (no Spanish fossils)
		CIVIL ENGINEERING/ MINING	- Public/private economic resource	- Quarries/Mines	- Selection of fossils for museums and educational collections

Fig. 1 Objectives and purposes identified for the main groups and the final location of moveable palaeontological heritage

the Geominero Museum, which holds 156 holotypes from a range of groups and ages, they are stored in special cabinets which ensure stable and appropriate atmospheric conditions.

The collecting of fossils for private use is not very common among palaeontologists, but it does occur. However, although the fossils are intended for private collection, scientific methodology is still applied and this means that the scientific information is usually not lost. Many palaeontologists manage their own research collections, and it is common for them to safeguard these during years of study or even their entire lives. This risks the total or partial loss of a collection and/or the information about it when the researcher retires (e.g. Prof. Sos Baynat's mineral collection was partially lost from the Extremadura Museum of Geology, "La familia de Sos y Baynat lamenta el mal estado de la colección de geología", 2014). The ideal situation would be for such people to donate their private collections to a public museum when they retire, and, to that end, museums and storage centres would need to comply with certain requirements to ensure the preservation of collections. Moreover, it is important for researchers to be able to deposit their collections easily in a place where fossils will be well preserved and available to the entire scientific community. It would be advisable that author research collections should not be disaggregated. For example, a collection of palaeontological samples from several Autonomous Communities could be stored only in one of these

communities museum or in a national museum. Eventually, collections donated by scientists can be used for science outreach and/or teaching at all educative levels.

The Autonomous Regions should specify the storage centre where fossil collections are to be housed after a research project is completed. Museums or storage centres which house fossil collections should fall under the auspices of the General State Administration or the Autonomous Regions, though there are also regional centres or local museums which safeguard palaeontological samples. Storage centres and museums which contain moveable palaeontological heritage should comply with the following requirements:

1. Palaeontological collections should be managed by palaeontologists.
2. Fossils should be identified by alphanumeric codes (institutional codes for marking and cataloguing) according to the standards of Science Citation Index publications.
3. Fossils should be stored in appropriate and stable conditions (humidity and temperature) to ensure their long-term preservation.
4. Museums should be responsible for supplementary documentation such as thin sections and publications.
5. Museums should be available for consultation or future studies by other researchers. This means that they should have regular opening hours and be easy to locate.

In the event that storage centres and museums (specified by the Administration in the fossil collecting permit) failure to comply with the requirements set out above, or the Autonomous Community does not own an adequate storage centre, we recommend that researchers be able to apply to deposit their collections in suitable museums which comply with the above-mentioned requirements. Thus, the lower to higher ranking for museums and storage centres should be as follows: local, county, provincial, regional and finally national.

Recommendations for Amateurs

Amateurs or occasional collectors usually buy fossils in local markets or collect them during field trips. Those fossils frequently have no, or low, heritage value. Thus, this group of people has a limited impact (Fig. 1). However, it is very common for taphonomic information, or even fossils themselves, to be lost. We propose a campaign in schools, museums and geological and palaeontological associations to raise awareness among the general public of the geoheritage value of fossils and their meaning.

Recommendations for Collectors

The main objective of collectors is to compile a private collection. They collect fossils to directly enhance their own collections and/or to swap with other collectors. They are usually non-professionals (i.e. not palaeontologists) who appreciate

beautiful, rare and special fossils and also collect common ones for the purpose of swapping. In general, they do not apply scientific methodology to sampling although some collectors apply it partially. This, however, is the exception, and normally the majority of taphonomic and geological information will be lost. The main problem associated with this group of people is that they are unable to distinguish the importance of a palaeontological site on the basis of its rarity or scientific significance.

In addition, the location, curation and storage of fossils may be inadequate, and this can lead to damage to, and loss of, specimens. Another issue relating to this group is what happens to the collections when the collector passes away. For example, palaeontological collections are then frequently sold or auctioned by the heirs (Fig. 2). In the best case scenario, these private collections are donated to regional museums and exhibition centres. This is in the route which we recommend for collectors and we ask them not to deal in fossils.

Recommendations for Dealers

In Spain, this group includes two very distinct profiles: (1) people who have a registered company and who declare this activity and pay taxes. They usually have businesses and participate in recognised mineral, gem and fossil shows; and (2) people who trade fossils illegally, feed the black market and usually participate in shows which do not possess a licence for this type of activity and/or trade on internet platforms. In this second case, there is a large black market for fossils at shows and fairs (specialist or otherwise). The legal trade, however,

Fig. 2 Exhibition of a fossil collection in a hotel lobby in Spain. This collection was bought at an auction



owns and trades specimens with a significant heritage and economic value, thereby guaranteeing their conservation. Our main recommendation is that people refrain from trading in fossils from sites considered to have a significant value in terms of palaeontological heritage. Dealers should not accept fossils which do not comply with the legal guarantees in force in Spain and should insist on an invoice from the supplier. In any case, commerce should not promote the illegal sale of fossils.

Recommendations regarding auctions which deal in moveable palaeontological heritage: We can often find advertisements for special offers and auctions of Spanish fossils, on occasions offering lots consisting of a large number of samples (<http://www.todocoleccion.net>; <http://www.subastas.catawiki.es>; <http://www.ebay.es>; <https://es.wallapop.com>). It is almost impossible to discover or check the origin of these and in the majority of cases, the location (geographic and geological data) is uncertain or lost. However, their economic value is usually low, except for examples of jewellery and/or decorative uses. They can prove very useful at any level of education for the purpose of bringing palaeontology to society. We recommend not including fossils in auctions when their economic value is outweighed by their educational value. If the seller is a person who has inherited the fossils or come across them by some other means, we recommend contacting scientists through universities or research centres in order to have them valued.

Recommendations for Civil Engineering and Mining Companies

Civil Engineering and mining companies remove large volume of rocks, minerals and occasionally fossils, either isolated or within sedimentary rocks. These companies use heavy machinery and even explosives for removing rocks and sediment in mines and quarries, and for ploughing, deforestation and excavation in civil engineering. There are three main recommendations:

1. Environmental Impact Assessments (EIAs) should expressly include geoheritage, as EIAs are the most effective preventive tools for conservation. Spanish Law 21/2013, regarding environmental assessment in Spain and which regulates EIAs, is usually used in the case of specific projects by individuals or companies, while the term “strategic environmental assessment” (SEA) is used in the case of policies, plans and programs proposed by official state bodies. Vegas et al. (2012) drew up a methodology for integrating geoheritage in EIAs. Moreover, EIA studies will focus primarily on in situ palaeontological heritage which is found in the natural environment. In the present case, sites of palaeontological, or sedimentological, interest

are the source of the fossils which constitute moveable palaeontological heritage.

In Spain, at regional level, Law 9/1999 in Castilla-La Mancha, regarding Nature Conservation, considers the EIA process as a mechanism for conserving and protecting geoheritage and, in particular, provides for a Catalogue of Elements of Special Geological Interest (Luengo et al. 2016).

2. Rescue collecting at the palaeontological sites, causing imminent destruction and subsequent safeguarding of the retrieved specimens, is essential for Earth Science conservation (Jakubowski 2004).
3. Private-public cooperation: concessions and assignments of fossils which form part of moveable heritage. Companies, during the performance of their activities, can contribute a percentage of the fossils (macro and microfossils) they extract for research and educational purposes. We can cite two highly fruitful examples of cooperation between companies and the well-known scientific institution “Fundación Dinópolis de Teruel”: the mining of clay by SIBELCO at Galve and the Santa María de Ariño coalmine by SAMCA (both in Teruel, NE Spain), where significant dinosaur remains were recovered and studied.

Proposal of an Ethical Code for Regulating the Collecting of Fossils: The Spanish Fossil Code

The Scottish Code (<http://www.snh.gov.uk/docs/B572665.pdf>) governing the collecting and care of fossils is very thorough (Scottish Government 2004) and is a model worth taking into account. It is based on its own laws which seem to be more permissive than Spanish laws. Although the Code considers several interesting points of view, excess information could incite people to collect fossils. One positive aspect of this Code relates to the recommendations it provides regarding the responsibilities inherent in the collecting of fossils in the field and their preservation thereafter. Another positive aspect is the appeal to buy and/or sell fossils ethically. However, research carried out by amateurs, as a matter of reality, is controversial from our point of view. In our opinion, the relationship between amateurs and palaeontologists proposed by the Code is too open, as it recommends publishing together. We feel that these publications could be educational ones aimed at bringing palaeontology to the general public, but scientific publications should be restricted to palaeontologists. The Scottish Code is an excellent example of the importance attached to palaeontology in the UK and the respect felt by the people for fossils. Although we cannot directly compare our code and laws with

those of Scotland, we value the efforts they make to ensure palaeontology is present in all levels of education.

A “Code of Best Practices” which provides for a system of permits for collecting fossils would be the best way to ensure that the five groups we have mentioned are aware of the importance of protecting and preserving moveable geoheritage. The proposed code for Spain is inspired by the Scottish Fossil Code, and it will be desirable for governments and professionals, together with all the people who constitute the five groups mentioned above, to begin to comply with the Code as soon as possible.

This Code considers that the collecting of fossils, whether by occasional collectors, professional collectors or dealers (Table 1), refers exclusively to *ex situ* fossils. Authorization would be required for gathering fossils from quarry waste heaps, and solely in places which are not palaeontological sites included in geoheritage inventories. The term “*ex situ* fossil” refers to a fossil which is outside its original geological context due to natural phenomena such as erosion, normally accumulated in debris and farmland.

Therefore, the Spanish Fossil Code which we propose includes the following recommendations:

1. The obligation to know current legislation governing the collecting of fossils in Spain (Table 1) and a ban on collecting fossils in protected natural areas established by Spanish Law 42/2007 regarding natural heritage and biodiversity.
2. A prohibition on the use of tools for removing fossils from rocks.
3. The obligation to obtain a permit for collecting fossils and to accept this Code.
4. Membership of a Palaeontology and/or Earth Science association, supported by a university and/or public research centre. In the event that the collector does not belong to an association, he or she will need to obtain the support of a university and/or public research centre, and apply for a permit as a private individual.
5. The application form for a permit to collect fossils will be similar to the one for hunting, fishing or collecting mushrooms but more restrictive given that fossils are non-renewable.
6. Town councils must establish local inventories of protected palaeontological sites, managed by qualified staff who will grant the licences or permits.
7. Local geoheritage inventories should be updated, including the Global Geosites List for Spain. We recommend that local inventories be updated regularly in order to improve their effectiveness. We propose that scientists provide information about their research and notify any events affecting the protection of new fossil sites.

8. Responsible collecting, i.e. the collecting of a limited number of fossils rather than every fossil found, so that fossils can be enjoyed by more people.
9. We recommend respecting and notifying *in situ* fossil finds as they may be important for scientists and for society as a whole. The find should be notified through the qualified staff responsible of local inventory, who in turn will contact experts. The term “*in situ* fossil” refers to a fossil which is found in its geological context.
10. Collectors from palaeontological associations which organise field trips to collect fossils should request permission from the environmental authorities. Those associations will be held responsible for any damage to moveable palaeontological heritage caused by their activities.

Conclusions

Five groups have been identified in the collection, possession and trading of Spain’s palaeontological geoheritage: (1) scientists, (2) amateurs, (3) collectors, (4) dealers and (5) civil engineering/mining. This analysis has been of strategic importance when it comes to proposing recommendations that guarantee the conservation of that geoheritage based on the five groups involved in collecting fossils, the purposes for which they are collected and where they are finally deposited.

One of the main problems in Spain is that there are two State laws which include fossils as elements of heritage. The 42/2007 Law includes fossils in the context of nature conservation and the Law/161985 Law in the context of historical and cultural heritage. There should be a single and unique law to govern the protection of fossils under geoheritage protection. Furthermore, fossils are protected and managed differently in each Spanish region.

The current and potential human impact on fossil sites and movable palaeontological heritage also needs to be assessed and taken into account in future Spanish legislation and the preparation of management plans, especially in natural protected areas as National Parks, Natural Parks and UNESCO Global Geoparks which include the requirements and application process for permits, the management of private and public collections, a code of ethics for collecting and awareness on the part of all of the groups involved. Moreover, state, regional and local authorities need to establish standards for natural museums which safeguard Spain’s palaeontological heritage.

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