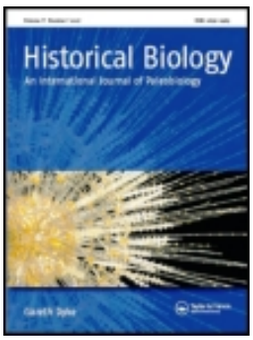

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The Krantz collections of palaeontology held at the University of Coimbra (Portugal): a century of teaching and museum activities

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The University of Coimbra holds a large repository of palaeontological collections bought from European mineral dealers, during the late nineteenth and early twentieth centuries. Among these specimens currently available at the Science Museum stand out three collections acquired from the Krantz house, between 1890 and 1913, for the Section of Mineralogy and Geology of the Natural History Museum. Their taxonomic diversity is high, as well as their geographic and stratigraphic wide-range origins, representing many classical locations and sedimentary formations of the European geology, and overseas countries. These collections have been used since long for teaching in practical classes of Natural Sciences at the University, using hands-on procedures. Together with other contemporary Krantz collections, known by several Iberian institutions, reveal an important heritage with both scientific and historical relevance that should be preserved, studied and reviewed from a scientific point of view.

Keywords: palaeontology; historical collections; Krantz; University of Coimbra; Iberian institutions

Introduction

It is common sense to assume that the teaching of Natural Sciences cannot be dissociated of practical training, that is, handling samples, specimens or models in classroom or laboratory environments. This reality presupposes that the repeated use of object-based learning procedures is highly effective as a complement of expositive theoretical contents, especially if based on 'good quality' collections, well organised and carefully prepared by the professor (Cain 2005). The direct engagement with objects, including those from Natural History collections, is a significant method to develop transferable skills like observation and deduction abilities, capacity of critical analysis and group share (Sparks 2010). It is also one of the best ways for a longer didactic recall, even if compared with modern techniques evolving digital analogies with object images (Simpson and Hammond 2012).

These teaching and learning 'old' strategies can be traced back to the Renaissance or even before that, but they are commonly associated with the philosophic ideas and ideals of the Enlightenment, when geology and life sciences emerged from closed and elitist circles to be available to large groups of citizens (Huxley 2007). This diffusion of knowledge, at least for the emerging middle class and bourgeoisie of that time, was the seed from which a new generation of scientists and engineers was born, and destined to lead the frontline of Industrial Revolution and its socioeconomic and political changes (Hobsbawm 1975; Hall 1976).

Collectables and collections are as old as civilisation itself, and the early collectors of natural objects date back to the Greco–Roman antiquity (Lewis 2004). This relationship between the discovery of Nature and the Human propensity to inquire helps to justify the profusion of Cabinets of Curiosities, Natural History Museums and private collections throughout the last centuries, including several in Portugal and Spain (Antunes 1986, 1992, 2000; Gruzman and Siqueira 2007; Brandão 2009a). It also explains why recent and old museum collections are so important for scientific, educational and outreach purposes, needing a continuous and professional care, and a conscientious procedure by the staff of each institution, following international guidelines or standards (Brandão and Restrepo 2006).

The Natural History collections are a mirror of the natural world and the single way for many people to observe alive or preserved natural beings, minerals, rocks and fossils away from their original environments. This capacity of being repositories from remote and inaccessible sites on Earth is one of the several reasons that can explain why old cabinets and museums from European institutions of education are so rich and diverse in

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historical collections dated from the late eighteenth, nineteenth and early twentieth centuries. Moreover, many of these collections have been extensively used for practical teaching and experimentation in classroom environments of universities and scientific academies (Antunes 1989). Some are enriched with rare specimens collected from long gone ecosystems, while others contain rich compilations of natural objects found in mines or outcrops when the Earth's surface was yet scarcely exploited from a scientific perspective.

One of the major contributions for such richness of Natural History collections, available for hands-on learning of generations of high school and university students, was the existence of specialised international dealers able to supply a variety of didactic and scientific objects for training, research and comparison purposes. This dealing activity was a sort of an in-between network of moving objects that joined field-work collecting, natural productions, science and teaching practices, economy and society (Fritscher 2012). The list of European firms and dealers that worked since the middle of nineteenth century is long, but only a few of those firms became actually famous and reached an overseas dimension with participation in universal exhibitions, thus being represented by custom-made collections in dozens of countries (Callapez et al. 2010; Callapez, Rocha, et al. 2011). This is the case of the *Krantz Reinisches Mineralien-Kontor*, Germany, still surviving after 180 years of intense activity.

Labelled Krantz collections of Mineralogy, Petrography and Palaeontology are long known in both Portuguese and Spanish institutions. Their overall diversity and contextualisation deserves in-depth and serious studies, in order to reveal their influence on the dissemination of geologic knowledge in both countries, since the late nineteenth century. As a first approach to this goal, the purpose of this paper is to reveal three Krantz collections of palaeontology currently held at the Science Museum of the University of Coimbra, in West Central Portugal (Figure 1(a)). These historical collections were bought for the Section of Mineralogy and Geology of the nineteenth and early twentieth centuries' Natural History Museum (Figure 1(b),(c)), and bring to light the importance of the

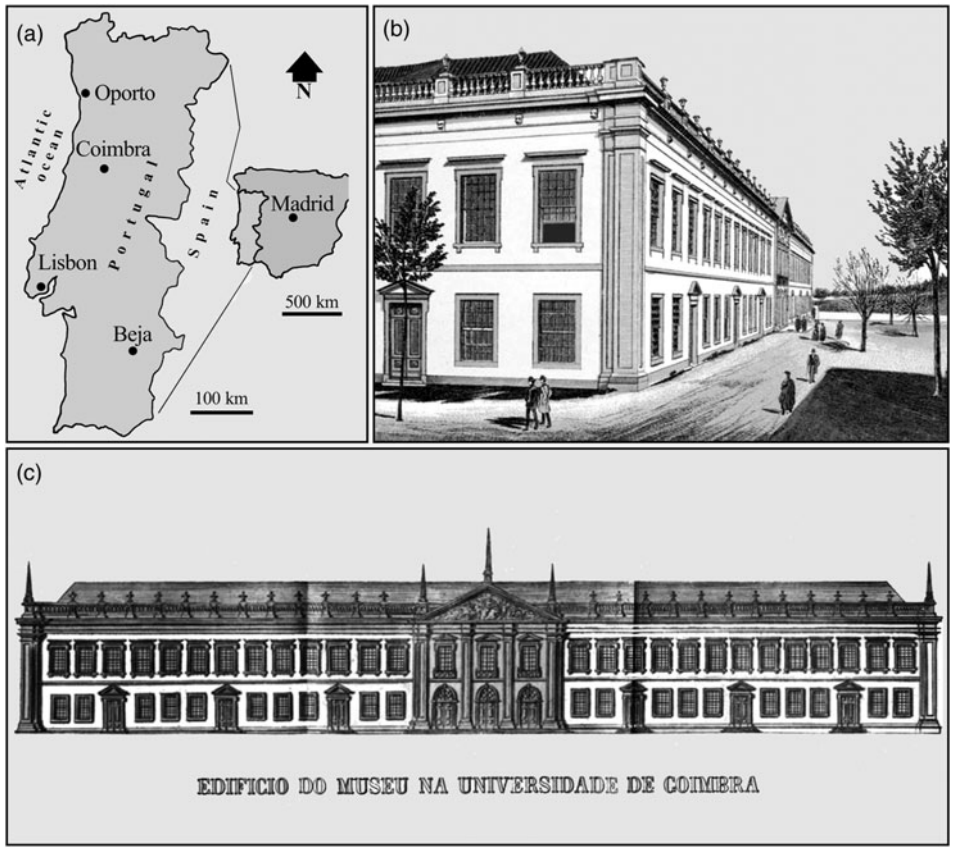


Figure 1. (a) Simplified geographical maps of Portugal and Spain showing the location of Coimbra and other towns related to Natural History collections and museums. (b, c) The College of Jesus of the University of Coimbra refurbished after 1772 to receive the Natural History Cabinet and, after 1837, the sections of Zoology and Mineralogy and Geology of the Natural History Museum. (b) Panoramic view ca. 1885 (original engraving from a late nineteenth-century touristic postcard). (c) Frontal view of the building showing the main entrance and a late eighteenth-century neoclassical pediment with a sculptural group showing an allegory to Natural History (original engraving from the 1868 yearbook of the University). Reproduced by permission of the Earth Sciences Department of the University of Coimbra.

German *Comptoir* as a major supplier of Iberian and worldwide higher learning and research institutions.

Studies of Natural History at the University of Coimbra

The University of Coimbra is one of the oldest in Europe, with roots that can be traced back to March 1290, when king D. Dinis I (1261–1325) created the *Studium Generale* in Lisbon, with confirmation by a papal bull of Nicholas IV (Braga 1892–1902; Rodrigues 1991). In 1308, the new Faculties of Arts, Canon Law, Law and Medicine were transferred to Coimbra, as a way to avoid repeated conflicts between the political power, the Catholic Church and Lisbon inhabitants. Coimbra had already a long tradition of teaching activities, due to a church school held at Santa Cruz Monastery (Serrão 1983).

Between 1338 and 1354, the university returned to Lisbon, and again in 1377, during the reign of king D. Fernando I. After a period of 160 years, these studies were definitely installed, in 1537, at the old medieval town of Coimbra (Torgal and Dias 2002) (Figure 2). Still during D. João III regency (1502–1557), the growing influence of conservative sectors of the Catholic Church culminated in the establishment of the Inquisition in Portugal (1536) and also the control of the university by the Jesuits (Carvalho 1986). This religious order was settled in the country for over 200 years, where it organised a teaching system based in theology and laws, leaving Natural Philosophy as a subordinate subject devoid of an effective practical teaching. The Jesuits became strongly rooted in several sectors of the nation, where many political problems arose, mostly related to South America possessions and the creation of 'states inside the state' under Jesuit *de facto* rule.

The reformation of the University of Coimbra only took place in 1772, during the reign of D. José I (1714–1777), when Sebastião José de Carvalho e Melo (1699–1782), Marquis of Pombal after 1770, initiated a long period as the prime minister and undertook serious and deep reforms that led the country in a sense of modernity. Nevertheless, these political and social changes included the expulsion of the Jesuit order from Portugal, after 1769, and the government of Pombal was characterised by a strongly autocratic leadership that forced many learned people to travel away, and to live in exile. This despotic and sometimes cruel behaviour limited the success of several new measures and motivated the recruitment of foreign lecturers as a way to replace persecuted Portuguese colleagues.

By this way, with the help of Italian teachers (Costa 1949) and showing a fine perception of the Enlightenment ideals acquired when he was ministry in London and Vienna, the Marquis of Pombal promoted the creation of an innovative Faculty of Philosophy with Natural History and Physics cabinets, a botanic garden and an astronomic observatory (Carvalho 1872; Aguiar 1972). The naturalist Domingos Vandelli (1730–1816) from Padua, initially invited for the Royal Museum and Botanic Garden of Ajuda, in Lisbon, was the first professor in charge of organising the Cabinet of Natural History with new collections and to teach Natural Philosophy at the new school (Amorim da Costa 1988; Cardoso 2002).

Figure 2. (Colour online) Panoramic view of Coimbra (Portugal) and its university from the atlas of Georg Braun and Frans Hogenberg (*Illustris Civitati Conimbriae in Lusitania ad flumen Illundam effigies*; ca. 1596). The square building lying on the left side of the top of the hill is the Jesuit college of Jesus where the Natural History cabinet was founded after 1772. Reproduced by permission of the Earth Sciences Department of the University of Coimbra.

This cabinet was settled on the first floor of the College of Jesus (Figure 1(b),(c)), a refurbished Jesuit building of 1542 adapted for this purpose (Baptista 2000, 2010). This 'cabinet of curiosities' inspired by the Enlightenment was the embryo of the Natural History Museum of the University, a transversal structure that survived with minor changes for more than two centuries, supporting teaching and research activities at the faculties of Philosophy (1772), Sciences (1911) and Sciences and Technology (1972) (Ferreira 1986, 1990a, 1998). It was the second museum of this kind to be created in Portugal, after the Royal Museum of Ajuda (Lisbon, ca. 1768) which was used for the education of the Princess and opened to the general public twice a week (Brigola 2003). The cabinet of Coimbra also preceded the first public museum of the kingdom, the *Sisenando Cenaculano Pacence* created at Beja (1791) (Teixeira 2000).

Both the faculty and the museum were innovative structures at the moment of their creation, in the sense that they were specifically adapted for this new way to teach Science with lectures complemented by practical demonstrations, as it was in use in many late eighteenth century institutions of Portugal and other European countries. Soon after its beginning, in 1777, the death of King José I caused the political downfall of Pombal and the return of many emigrates and excluded learned people. This period known as the 'Viradeira' was followed by a cultural renewal of Science, Arts and Letters under the auspicious of the new Queen, Maria I of Portugal. Special emphasis goes to the foundation, in 1779, of the Royal Academy of Sciences of Lisbon, where the teaching of Natural History with manipulation of specimens began in 1792, as the Maynense class, and a museum housed large collections (Carvalho 1993).

At the University of Coimbra, the educational effort was supported by the first manuals of Portuguese authorship, namely the *Compendio de Botanica* (1788) by Avelar Brotero (1744–1828), the *Diccionario dos termos technicos de Historia Natural: extrahidos das Obras de Linnéo* (1788) by Domingos Vandelli, the *Introductiones Zoologicae* (1794) by Ribeiro de Paiva (1747–1831) and the *Metallurgicae Elementa* (1798) by Manuel Barjona (1760–1831) (Ferreira 1990b).

At the same time, it was decided to increase the level of specialisation of new teachers. Some of them, like José Bonifácio d'Andrada e Silva (1763–1838), António Monteiro (1769–1839) and Paulino de Nola (1759–1831) benefited from large allowances in the emergent scientific centres of Paris and Freiberg (Ferreira 1988b, 1992, 1998; Pinto et al. 2011), where they published their first works in international magazines. These scholars acquired scientific books and tools, and they also collected specimens to send back to the classrooms and laboratories of Coimbra.

After a shy opening to the Industrial Revolution paradigm (Hobsbawm 1975), the first half of the nineteenth century was a time of political crisis and socioeconomic instability for the Iberian states, which suffered the devastation of the Peninsular War (1807–1814) (Glover 2001) and the effects of several civil conflicts. Soon after the triumph of the Liberalism in Portugal (1834), two polytechnic schools were created in Lisbon and Oporto to teach military engineering and other areas of more diverse applicability, including a subject named 'Introduction to the Natural History' (Cunha 1937; Carvalho 1986). The Polytechnic School of Lisbon, lately recognised as the Faculty of Sciences of the Lisbon University (1911), was specially benefited when the Natural History collections housed at the Royal Academy of Sciences were transferred to its new building, in 1858.

Meanwhile, the teaching of Natural History subjects at the University of Coimbra retained the same philosophical system, far away from the increasing need of bachelors with skills to work in factories and mining explorations. This state of art was real until the last decades of the nineteenth century, despite the existence of enough collections to begin a practical teaching more adjusted to the professional requirements of industry. These collections included, for instance, a large set of minerals mentioned by German catalogues of 1818–1836 (Pinto et al. 2011), enlarged at the time of professors Fernandes Thomaz (1807–1871) and Pereira Jardim (1818–1887) (Ferreira 1987, 1988a; Pinto and Marques 1999).

By that time, the passive condition of the museum and the relative detachment of curricula from the reality of the country, in spite of the Geological Commission being already actively working on the stratigraphy and cartography of the territory, were signs of an obvious truth: the teaching of Natural History at the University of Coimbra was, soon after the Regeneration period of 1852, losing its hegemony while the polytechnic schools of Lisbon and Oporto grew substantially in importance, and new industrial schools were created in these cities, with the purpose of a more practical education (Costa et al. 2009, 2011, 2012; Costa, Chaminé, Brandão, et al. 2010; Costa, Chaminé and Callapez 2010). Thus, the efforts of the Faculty of Philosophy made by the end of the century with the purpose of having a museum and laboratories provided with new specimens, models, maps, books and equipments were also an attempt to modernise the University of Coimbra and its courses, face to face to a very competitive teaching system and a significant nationwide shortage of specimens.

Acquisition of fossils from the Krantz dealers

By the second half of the nineteenth century, Portugal stood in the way of modernisation and economic development. It was a time of flourishing for several sectors of industry and mining activities, with the

improvement of basic infrastructures and the exploration of new markets and sources of raw materials, including geological resources from the colonial territories of Africa, also disputed by the British and the Germans (Callapez et al. 2008; Brandão, 2010a; Callapez, Rocha, et al. 2011). These new challenges and an inevitable competition by the contemporary schools of Lisbon and Oporto were imperative factors that increased the need of reforms at the Faculty of Philosophy.

In 1885, several changes took place in the structure of the Natural History Museum, including a restructuring plan in four independent sections that separated anthropology, botany and zoology from the areas of mineralogy and geology (Ferreira 1998). These administrative changes were the starting point for an enlargement of the available space for collections, newly refurbished with furniture. The favourable circumstances of that period allowed also large acquisitions of tools and Natural History specimens. During the decades that preceded World War I, dozens of transactions were made with European *comptoirs* specialised in didactic and scientific materials. In our opinion, they deserve further studies to review old classifications and the historical meaning of the collections (Callapez et al. 2010; Callapez and Brandão 2011).

For the Section of Mineralogy of the Natural History Museum, a structure created to support several disciplines in the sphere of geology; this was the awaited opportunity to acquire large collections of minerals, rocks, fossils and models, many of them absolute novelties for the Portuguese teachers. The director of the section was the notable mineralogist Gonsalves Guimarães (1850–1919) (Carvalho 1942), later assisted by Ferraz de Carvalho (1878–1955) (Morais 1955). Both were involved in the acquisition of several thousands of specimens and models for the museum, including from the Krantz house. In particular, these Krantz collections of palaeontology were bought in August 1890, June 1909 and November 1913, respectively, by the amounts of 1189,00, 1884,00 and 627,50 D.M. (Figure 3).

It is interesting to underline that the founder of the *comptoir*, the German mineralogist and mineral collector Adam August Krantz (1808–1872) was also a Ph.D. student in Freiberg (Krantz 1984; Schmidt 1997), following an academic formation much alike to those of the Coimbra's teachers above mentioned, José Bonifácio and Paulino de Nola. The original 'mineral shop' was created in 1833, during the Freiberg years, and after a brief period in Berlin; it was reopened around 1850, in Bonn, as the *Reinisches Mineralien-Comptoir Dr. A. Krantz* (Cleevely 1983). After the death of its founder, the *comptoir* was managed by his son-in-law, and from 1891 onwards, by his son Friedrich Krantz (1859–1926), he was also a mineralogist with a Ph.D. (Krantz 1984).

The first invoice of the Portuguese collections (27 August 1890) is just from this transitional period, when Friedrich Krantz had already joined the firm, but was not yet its manager. On the second invoice (1909), the house name was changed to *Dr F. Krantz Reinisches Mineralien-Contor*, as an announcement of its new manager.

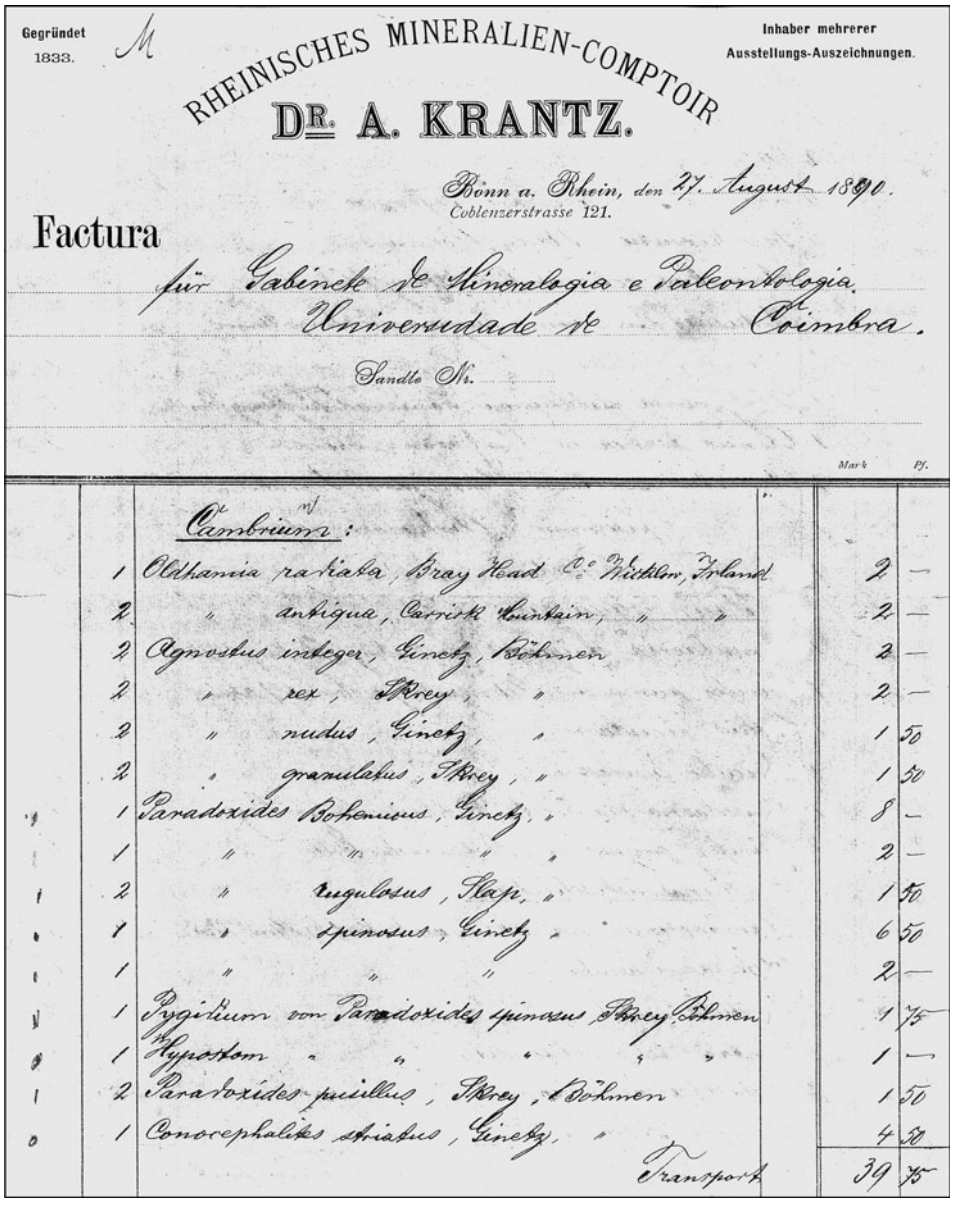
Unfortunately, more than a century after their arrival to the University of Coimbra, a repeated use of these and other contemporary collections in practical classes and years after years of poor curation resulted in the degradation or loss of many specimens and objects of different nature. This situation was not exclusive of Coimbra, since the excessive manipulation of specimens difficult to replace, the lack of care and even theft were common to other Iberian institutions. Nevertheless, several attempts have been recently made to recover this precious heritage, including a digital database (Paredes et al. 2007, 2009), new exhibitions (Callapez et al. 2010; Callapez, Rocha, et al. 2011), historical analysis (Callapez and Brandão 2011), taxonomic review of brachiopods (Schemm-Gregory and Henriques 2012, 2013a, 2013b) and Jurassic bivalves (Paredes and Callapez 2013).

Overall view of the collections

The purchase documents are preserved in the historical archive of the Earth Sciences Department of the University of Coimbra. From the original invoices available it can be noted that the dimension, taxonomic composition and geographic range of these Krantz collections were of 1739 specimens of invertebrates, and a few fossil plants and vertebrates collected not only in well-known European sites, but also from North-America, Brazil, North-Africa and Australia (Table 1).

As usual for many contemporary collections gathered in Natural History *comptoirs*, they were organised for taxonomic and stratigraphic purposes, as a didactic tool intended to offer an overall synthesis of the characteristic fossil faunas and floras of the Phanerozoic periods described on the school manuals of Geology. This broad view was mainly based on late nineteenth-century classical units and sites of Western and Central Europe, the USA and other foreign countries, from which many thousands of samples were collected by the Krantzes themselves, or gathered through their vast network of employees, correspondents and dealers.

All samples were supplied with handwritten custom labels with specimens' classification, age, provenance and price, and numbered accordingly to a printed Krantz's catalogue. From these, the 'Nr° 2^b – Palaeontologie' was available at the time of the 1909 and 1913 collections, as can be confirmed by a carefully annotated copy kept on the historical archive (Figure 4).


Gegründet 1833.

RHEINISCHES MINERALIEN-COMPTOIR

DR. A. KRANTZ.

Inhaber mehrerer Ausstellungs-Auszeichnungen.

Bonn a. Rhein, den 27. August 1890.
Coblenzerstrasse 121.

Factura

für Gabinete de Mineralogia e Paleontologia.
Universidade de Coimbra.

Sandte Nr.

			Mark	Pf.
		Cambrium:		
	1	Oldhamia radiata, Bray Head Co. Wicklow, Irland	2	—
	2	" antiqua, Carrick Mountain, " "	2	—
	2	Agnostus integer, Ginetz, Böhmen	2	—
	2	" rex, Skrey, "	2	—
	2	" nudus, Ginetz, "	1	50
	2	" granulatus, Skrey, "	1	50
	1	Paradoxides Bohemicus, Ginetz, "	8	—
	1	" " " "	2	—
	2	" rugulosus, Skap, "	1	50
	1	" spinosus, Ginetz, "	6	50
	1	" " "	2	—
	1	Pygidium von Paradoxides spinosus Skrey Böhmen	1	75
	1	Hypostom " " " "	1	—
	2	Paradoxides pusillus, Skrey, Böhmen	1	50
	1	Conocephalites striatus, Ginetz, "	4	50
		Transport	39	75

Figure 3. Front page of the large invoice sent in 27 August 1890 by the A. Krantz *comptoir* of Bonn (Germany) to the *Cabinet* of Mineralogy and Geology of the University of Coimbra (Portugal), listing a set of trilobite specimens collected from the Cambrian units of Bohemia (Czech Republic). Reproduced by permission of the Earth Sciences Department of the University of Coimbra.

First acquisition, mainly Palaeozoic

The first documented collection of Krantz fossils to arrive at the Section of Mineralogy and Geology (1890) was a set of 381 samples with 686 specimens of invertebrates, mainly brachiopods, bivalves, gastropods, cephalopods, trilobites and corals, all together with a short number of small vertebrate specimens, fossil algae and ichnites (Table 1; Figures 5(a)–(d) and 6(a)–(d)). This was certainly a fascinating collection for teachers and students unfamiliar with the amazing diversity of the fossil record, as it can be perceived through the large invoice with 14 pages of detailed information about the taxonomy, sampling sites, number of fossils and items, and the price per specimen. This document was organised according to the relative age of the stratigraphic units represented, and then by taxonomic position.

This is a very specific stratigraphic collection that records characteristic fossil assemblages from the Cambrian of Bohemia and from the classical units of the German Palaeozoic and Triassic. The *Old Red Sandstone* of the UK, the Belgian Carboniferous and the Triassic of Austria are also present, including interesting examples of early fish species. Ordovician and Silurian faunas are

Table 1. Overall data of the Krantz collections bought to the Section of Mineralogy and Geology of the Natural History Museum of the University of Coimbra, respectively, at 1890, 1909 and 1913.

A – country	1890	1909	1913	B – taxonomy	1890	1909	1913	C – period-Epoch	1890	1909	1913
Austria	89	51	9	Pseudofossils	–	1	–	Cambrian	40	17	7
Belgium	79	4	2	Ichnofossils	4	3	3	Ordov/Silurian	–	117	9
Bosnia	–	3	1	Alghae	1	–		Devonian	381	76	4
Czech Rep.	29	39	3	Stromatolites	–	2	–	Carboniferous	123	53	12
Denmark	1	2	–	Plant remains	–	–	5	Permian	43	24	4
France	17	234	8	Foraminifera	–	1	3	Triassic	99	47	20
Germany	401	313	23	Radiolaria	–	–	1	Jurassic	–	218	16
Ireland	10	5	6	Porifera	–	29	5	Cretaceous	–	193	13
Italy	–	57	6	Archaeocyata	–	–	1	Palaeogene	–	116	1
Latvia	–	2	–	Scyphozoa	–	1	–	Miocene	–	44	–
Luxemburg	–	–	1	Anthozoa	29	98	3	Pliocene	–	26	1
Nederlands	–	33	–	Bryozoa	6	133	–	Quaternary	–	30	2
Norway	–	1	–	Brachiopoda	323	93	11	*Sum*:	686	961	89
Poland	–	2	–	Bivalvia	113	95	8				
Russia	–	26	1	Scaphopoda	1	–	–	D – period – regional unit	1890		
Spain	–	3		Polyplacophora	1	–	–	*Cambrium*	40		
Sweden	4	26	1	Gastropoda	62	198	8	*Taunusquartzit*	7		
Switzerland	–	1	–	Cephalopoda	38	95	29	*Hunsruchschiefer*	11		
Turkey	–	–	3	Echinodermata	34	136	8	*Untere Coblenzschicten*	69		
Ukraine	–	2	–	Annelida	–	20	–	*Haliseritenschiefer*	14		
UK	47	75	14	Arthropoda	50	49	4	*Coblenzquartzit*	32		
Angola	–	1	–	Graptolithina	1	7	–	*Condrifenschiefer*	9		
Algeria	–	–	2	Placodermi	1	–	–	*Obere Coblenzs*	114		
Australia	–	2	2	Chondrichthyes	8	–	–	*Rhenan*	16		
Brazil	–	–	1	Acanthodii	2	–	–	*Famenien*	102		
Canada	–	2	–	Osteichtyes	9	–	–	*Oldred*	7		
Egypt, Iran	–	2	–	Amphibia	1	–	–	*Anthracifère*	123		
Japan	–	1	1	Sauropsida	2	–	–	*Permien*	43		
USA	–	73	3	*Sum:*	686	961	89	*Buntsandstein*	7		
New Zealand	–	1	–					*Tyrolien*	92		
HMS Challenger	–	–	2					*Sum*:	686		

Note: A, number of specimens by European country, non-European country, and collected in the *HMS Challenger* expedition; B, number of specimens recorded from each major taxonomic group; C, number of specimens by stratigraphic age; D, number of specimens from the 1909 collection related with each local/regional unit or stage (Palaeozoic and Triassic).

absent, but those of Devonian age stand out as an interesting set with a few hundred specimens collected from German Lower Devonian classical areas such as Eifel, Gerolstein and Coblenz (Rhineland-Palatinate district), and Lahntal (Marburg-Biedenkopf district). These outcrops are part of the Variscan massifs of the Reinisches Schiefergebirge, Thüringisches Schiefergebirge and Harz Mountain (Schemm-Gregory and Henriques 2012). For the related geognostic succession, the Krantz staff used the local classical units (*Taunusquartzit, Hunsruchschiefer, Untere Coblenzschicten, Haliseritenschiefer, Coblenzquartzit, Condrifenschiefer, Obere Coblenzschicten*: Asselberghs 1921). This fact is an interesting example of the introduction of the German stratigraphic nomenclature in Portugal, as a complement to several examples of manuals bought for the university libraries.

Such detailed collection was ordered side by side with Meso-Cenozoic collections bought from French and Italian dealers (Callapez et al. 2010; Callapez, Gomes, et al. 2011; Callapez, Rocha, et al. 2011). The purposes of Gonsalves Guimarães were obvious: to enrich the museum with a large and diverse stratigraphic collection of the characteristic fossils on which are based the definition of the geological stages and from European classic locations mentioned in the manuals adopted for the contemporary courses. At the same time, these collections were a useful way to reveal aspects of evolution and fossil record based on examples of extinct species from different ages. It is interesting to note that the Darwinism was introduced at the University of Coimbra in 1865, by the botanist Júlio Henriques (1838–1928) (Henriques 1865). Gonsalves Guimarães was the author of a thesis on the 'specialisation of domestic animal breeds' (1875), and thus, a teacher with knowledge of evolutionary ideas and sensible to the importance of fossils as an argument to the new theory.

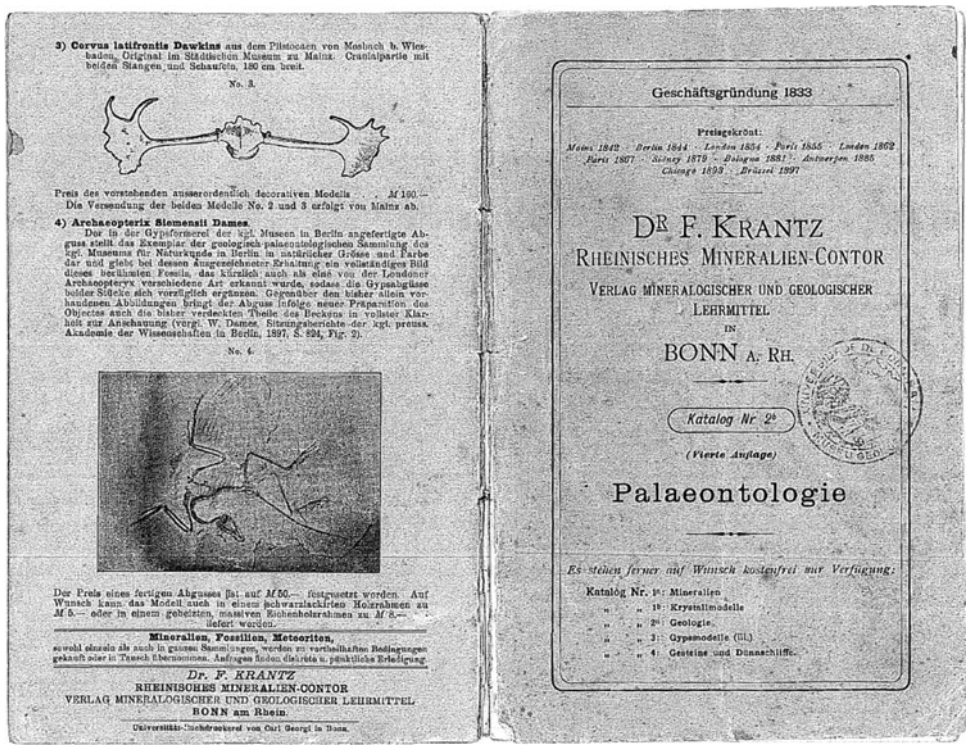


Figure 4. Back and front pages of the Catalogue 2b – palaeontology published by the *Reinisches Mineralien-Contor* of F. Krantz with detailed lists of specimens, scientific and didactic collections, and models. The figured book shows a bluish librarian mark of the Geological Museum of the University of Coimbra (Portugal), and it is extensively annotated with an indication of the bought specimens. Reproduced by permission of the Earth Sciences Department of the University of Coimbra.

Figure 5. (Colour online) Samples of the Krantz palaeontological collection of the University of Coimbra (Portugal) bought in August 1890 for the Section of Mineralogy and Geology of the Natural History Museum. Gastropod specimen (a) and A. Krantz custom label of MCUC-2669 (b) classified as *Euomphalus pentangulatus* Goldfuss, from the Carboniferous of Kildare, Dublin, Ireland; A. Krantz custom label (c) and bryozoan specimen MCUC-1346 (d) classified as *Fenestella plebeia* McCoy, from the Carboniferous of Halkyn, North-Wales, UK. Reproduced by permission of the Science Museum of the University of Coimbra.

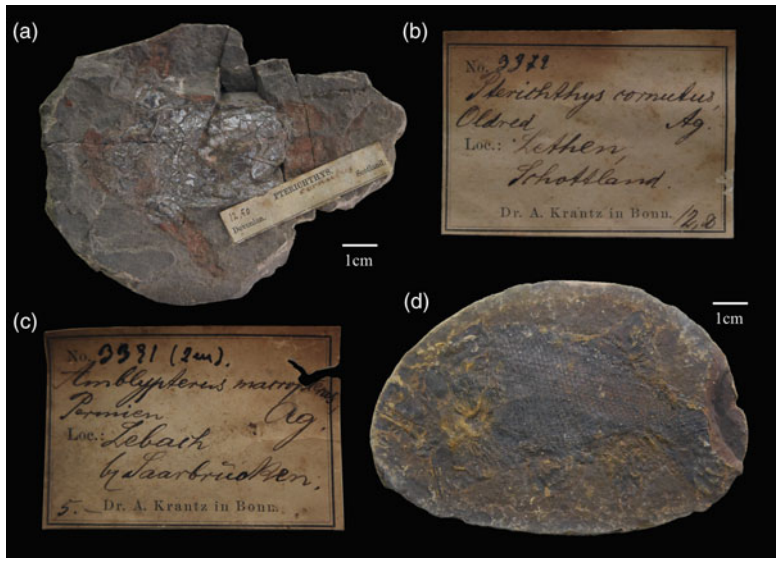


Figure 6. (Colour online) Samples of the Krantz palaeontological collection of the University of Coimbra (Portugal) bought in August 1890 for the Section of Mineralogy and Geology of the Natural History Museum. Armoured fish specimen (a) and A. Krantz custom label of MCUC-3379 (b) classified as *Pterichthys cornutus* Agassiz, from the Middle Devonian (Old Red Sandstone) of Lethen Bar, Scotland, UK; A. Krantz custom label (c) and fish specimen MCUC-3331 (d) classified as *Amblypterus macropterus* Agassiz, from the Permian of Lebach, Saarland, Germany. Reproduced by permission of the Science Museum of the University of Coimbra.

Second collection, a wide range of specimens

The purchase of 1909 is the larger and more diverse of these collections, reaching a sum of 572 samples with 961 specimens of invertebrates, and a few pseudofossils, ichnofossils and foraminifera. The relative abundance of the most representative taxonomic groups of invertebrates is more or less equivalent: corals, bryozoans, brachiopods, bivalves, gastropods, cephalopods and echinoids. Sponges, annelids and trilobites are also fairly well represented (Table 1; Figure 7(a)–(d)).

From a stratigraphic point of view, the collection spans the whole Phanerozoic major intervals. There are specimens from 27 worldwide countries, 19 of them European. This geographic diversity reveals the international

Figure 7. (Colour online) Samples of the Krantz palaeontological collection of the University of Coimbra (Portugal) bought in June 1909 for the Section of Mineralogy and Geology of the Natural History Museum. Crinoid specimens (a) and F. Krantz custom label of MCUC-1471 (b) classified as *Extracrinus briareus* Miller, from the Lias of Whitby, Yorkshire, England, UK; F. Krantz custom labels (c) and trilobite specimen MCUC-1540 (d) classified as *Konocoryphe kingii* Meck, from the Cambrian of Antelope Island, Utah, USA. Reproduced by permission of the Science Museum of the University of Coimbra.

dimension reached by the Krantz house at the time, and its ability to establish a universal network of correspondents, both naturalists and collectors interested in the market of fossil changes, sales and acquisitions. The best recorded countries are Germany and France, followed by Austria, Italy, the UK and Russia.

As usual on first rate collections of this epoch, many of the classic European areas and sites are also present, including dozens of locations mentioned in the *Prodrome* of d'Orbigny (1849–1852), or in the *Principles of Geology* of Lyell (1830–1833) and other widely known stratigraphic manuals of that period.

This collection was bought 1 year before the fall of the Portuguese monarchy, during a time of major socio-economic and political changes in Europe, which culminated on World War I. By this time, the Director of the Section of Mineralogy and Geology was yet Gonsalves Guimarães, but a discipline of 'Geology and Geophysics of the Earth' was already taught by Ferraz de Carvalho (Ferreira 1998), a teacher knowledgeable about the scientific areas of stratigraphy and palaeontology. With the purchase of all these specimens, they achieved a significant enrichment of the overall palaeontological collections, taking the advantage of new rooms available for the Natural History Museum. At the same time, they significantly contributed to grant an international dimension to the collections available to the scientific community, providing contact with materials that were only known through specialised publications acquired by the university.

Last purchase, picked one by one

Despite a short difference of 5 years, this last collection (1913) was already bought after the instauration of the Republican regime (1910) and the main reformation of the high teaching institutions of Portugal (1911), which replaced the Philosophy and Mathematics Faculties by the Sciences Faculty, and created the Historical-Natural Sciences bachelor at the University of Coimbra (Ferreira 1998).

This is a small but diverse set bought with specimens careful chosen to complete some scarcely represented taxonomic groups of the palaeontological collections. Its 89 specimens record fossil sites from 18 worldwide countries, 14 major taxonomic groups and all Phanerozoic Periods and Epochs, except for the Miocene. The scarce representation of Neogenic fossils can be related with the existence of other museum collections, consisting mostly of invertebrates of this age and thus making unnecessary the acquisition of additional specimens. This reveals a careful choice of particular specimens from the Krantz Catalogue available at the University of Coimbra, which has handwritten notes of the bought items (Table 1; Figure 8(a)–(d)).

Another interesting fact is the presence of *Glossopteris* specimens and several planktonic foraminifers and radiolarians collected from the HMS Challenger oceanographic expedition (1872). They suggest that some early ideas about the Gondwana and continental drift made by Suess and other precursors of Wegener were already known and generally accepted in Coimbra, especially by researchers like Ferraz de Carvalho, who studied

Figure 8. (Colour online) Samples of the Krantz palaeontological collection of the University of Coimbra (Portugal) bought in November 1913 for the Section of Mineralogy and Geology of the Natural History Museum. Fern specimen (a) and F. Krantz custom label of MCUC-1551 (b) classified as *Glossopteris indica* Schimper, from the Permian of Arroio dos Cachorros, Rio Grande do Sul, Brazil; F. Krantz custom label (c) and icnofossil specimen of MCUC-1545 (d) classified as *Cruziana goldfussi* d'Orbigny, from the Ordovician of Mayenne, Loire, France. Reproduced by permission of the Science Museum of the University of Coimbra.

geophysics, and was, for a long time, director of the Geophysical Institute founded in 1864.

Other contemporary collections held in Iberian institutions

The *comptoir* founded by August Krantz was one of the most important of that time, with several noteworthy catalogues available and many collections sold to Iberian institutions. Besides Coimbra, several other relevant examples are documented in the official Portuguese Geological Survey and at the high-level schools of Lisbon and Oporto. In Spain, there are contemporary Krantz collections at the Central University and the School of Mines of Madrid, among other public institutions.

The Portuguese Geological Commission (1957–1918), later on Portuguese Geological Survey, soon created a museum where the samples collected during fieldwork campaigns were arranged and preserved after classification, for further comparison with new acquisitions (Brandão 2009b). This was achieved side by side with several other stratigraphic collections bought from European suppliers, including the eldest geological warehouse worldwide: the Krantz. These collections date back to 1870–1871 and they were ordered by Carlos Ribeiro (1813–1882), chief engineer and director of the 'Commission'. They included many minerals and a wide stratigraphic collection with rocks and fossils from Western and Central Europe, representing the various stages of geological time. From the palaeontological specimens lot only remains about one half of the original one (over 500 samples), mainly of invertebrates, having the other specimens been lost throughout the years, during successive manipulations and, eventually, transferred to other institutions, universities and secondary schools, in so far as that the assemblage and supply of didactic geological collections became a legal assignment of these state services (Brandão 2010b).

Nowadays, fossils delivered by Krantz constitute about 20% of all specimens from the foreign palaeontological collections incorporated in the late nineteenth century (Brandão and Almeida 2003), mostly resulting from exchanges with other geological institutes, museums and universities.

The presence, composition and situation of the Krantz didactical collections in Spain are, to date, scarcely studied. One of the main difficulties to the study of these and other collections (especially those of mineralogy, petrology and palaeontology) is the possible acquisition of specimens by means of interchange by other geological materials (Perejón 2013), and the absence or disappearance of original labels and bills.

Different mineralogical, petrological and crystallographical Krantz collections can be found in several Spanish

Figure 9. (Colour online) Samples of the Krantz palaeontological collection of the National Museum of Natural Sciences (Madrid, Spain). Specimen (a) and labels of MNCNI-03764 (b) classified as *Bronteus flabellifer* Barrande, from the Devonian of Dlouhá hora, Bohemia, Czech Republic. Specimen (c) and labels of MNCNV-08926 (d) classified as *Stigmaria ficoides* Sternberg, from the Carboniferous of Mons, Bergen, Belgium. Reproduced by permission of the National Museum of Madrid.

institutions, including some centres of higher learning and research (Central University, Geominero Museum, School of Mining Engineers: Puche and Mata 1992; Lozano 2004) and numerous schools of secondary teaching widespread by different cities (Barcelona, Sevilla, Vitoria, Santiago, Valencia, Zaragoza, Granada: Montero 2003) of the country.

Regarding the palaeontological Krantz collections in Spain, the National Museum of Natural Sciences (MNCN) nowadays holds, at least, six specimens of fossil invertebrates and three of palaeobotanical remains in its database (Figure 9(a)–(d)). Nevertheless, the total number of Krantz specimens housed in this institution could be slightly higher, as the whole of its historical palaeontological heritage is not, to date, systematically revised and recorded in its database (Santos, pers. comm.). Montero (2003) studied the material and respective documentation of the palaeontological heritage of the MNCN revealing, at least, two important acquisitions to the Krantz house (in 1882 and 1884). Therefore, the scarce Krantz palaeontological material present to date in this institution only represents the small remains of a high number of purchased specimens to this and other specialised *comptoirs*, mostly of Germany, the UK and France, or particular donations during the last half of the nineteenth and the first third of the twentieth centuries. The reason of these numerous acquisitions is that one of the main purposes of the MNCN was, besides the study and preservation of the best and most representative specimens of the natural world, the compilation, concession and sending of didactic geological collections to different centres of higher and secondary learning and research (see above).

Conclusions

More than a century after its acquisition by the University of Coimbra and despite decades of hands-on teaching practices and museum activities, about 70% of the Krantz collections of Palaeontology used in the area of Mineralogy and Geology, still exist. This heritage is part of the historical collections of the recently created Science Museum of the University, waiting for a long curatorial work that will allow to highlight their value as a historical testimony of a crucial time to the improvement and dissemination of geological knowledge, and to the major scientific advances on taxonomy, stratigraphy and history of Earth that can be explored through museum activities.

Since their early incorporation in the whole geological collections, they were mixed and catalogued with specimens bought from other dealers and displayed all together in the museum. Their main function was to be a close support for practical classes associated to the curricula of geology. This means that, at least, part of the samples were regularly handled year after year, helping to illustrate theoretical contents related to sedimentary rocks, the rock cycle, stratigraphy, taxonomy and palaeontology, history of the Earth system and continental drift, among others. This purpose was plenty fulfilled in what concerns the academic formation of several generations of students, many of them future high school teachers or researchers. Thus, it can be stated that the collections played a significant role as a way to approach new students in Earth sciences from the subjects of palaeodiversity, evolution and fossil record. In the meantime, they were a positive contribution for the progress of researches and the dissemination of geological knowledge.

Besides their scientific value, the Krantz palaeontological collections held at the University of Coimbra and other Iberian institutions reveal an unmistakable historical importance for the contextualisation of this *Belle Époque* of Geology, a time span of several decades that preceded World War I and coincided with the ultimate affirmation of this area of human knowledge as a major branch of modern sciences.

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