'Visual Histories' Science Visualization in Nineteenth-Century Natural History Museums

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Abstract

This article attempts to shed light on the complex interdependencies between science, art and popular visual culture in the context of nineteenth-century natural history museums. Natural history museums are still underestimated agents for (artistic) scientific visualizations. Built as 'visual narrators' they became a form of mass media that conveyed scientific knowledge to diverse audiences. This article is a first attempt to bring order into the broad field of science visualization and to describe its significance for the popularization of the natural sciences. The visual outreach of museums such as the Natural History Museum Vienna went far beyond their circle of visitors. By creating and presenting first rank artistic imaginaries, they inspired highly circulated teaching devices such as school wall charts, textbooks or models, thus influencing our collective visual memory. These images subconsciously shaped the way we perceive the world as it is and as it could have been.

Introduction

Images are powerful. They convey ideas effectively and subliminally via the senses giving them the power to reach beyond the elite learned population to wide and diverse audiences. As the German ethnologist Wolfgang Brückner pointed out, both intellectual revolutions of modern European history were facilitated by iconic revolutions where new methods of print publishing, combined with the possibility to reproduce images, prepared the background for the intellectual liberation that led the way to modernity (Brückner 1973: 13). The first example of an iconic revolution came with the invention of letter printing combined with wood-cut and copper engraving in the fifteenth-century, and the second example was in the nineteenth-century with chromo-lithography and the emergence of photography. The new technologies of the nineteenth-century combined with the automatization of printing opened the possibility of a hitherto unprecedented mass production and reproduction of images. It is no wonder that these innovations were also put into service by science. Science visualizations are border-crossers between independent art works and tools for research and teaching.

Until recently, scholarly research on visual culture has concentrated almost exclusively on the dissemination of art through mass reproduction and explored its emancipatory potential for the growing bourgeoisie (Brückner 1973; Uphoff 2002; Stöcker 2018). While the inclusion of art reproductions into schools and bourgeois homes has already been very well researched, and the significance of their appropriation for the emancipation of the bourgeoisie has already been emphasized several times, this has not yet been the case with scientific visualizations. The discovery that, for example, the decorative program of the Natural History Museum Vienna (hereafter NHM Vienna) inspired school wallcharts, and that through this found its way into bourgeois houses (Jovanovic-Kruspel 2019), shows that scientific as well as artistic visualizations were freed from elitist shackles thanks to the new means of reproduction. As the sources show, this example for the appropriation of a scientific imagery was not the only one. Rather, it can be assumed that - thanks to the new reproduction techniques - scientific visualizations also found their way into the private sphere of the bourgeoisie (Jovanovic-Kruspel 2019).

Although British and US-scholars have increasingly started to investigate the relationship

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between visual culture, the public and science (Lightman 2012), there are still many gaps. The main reasons why science visualization has been a blind spot of research for a long time are:

> 1) Most visual materials of science were not regarded as works of art in their own right and were therefore not preserved or collected. Stored in scientific institutions, they were regarded as simple tools for scientists. Once made obsolete by scientific progress, they were frequently thrown away.
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> 2) Many of the images created for the dissemination of science in popular culture were not published in an enduring form like in books or journals. Instead they belong to the realm of 'applied images' that were produced in large quantities as teaching tools for new mass audiences. This included wall charts, collectible pictures, stereoscopic images, magic lantern slides, models etc. Many of these images did not survive and therefore we still know very little about the way they were used in lectures and 'science theatres' and different kinds of exhibitions (world exhibitions, science fairs, museums and travelling exhibitions like the 'Human Zoos').

Museums as 'visual narrators'

Within these developments of intellectual and iconic methods in science communication, the role natural history museums played is worth investigating more closely. Starting out as depositories for growing collections amassed over the previous centuries and decades, a new demand for purpose-built museum-institutions emerged during the nineteenth-century. The museums are probably the most prestigious manifestations of the new visual culture of the nineteenth-century. They must be understood as temples for the worship of vision. According to the idea of 'visual education' ('Anschauungsunterricht' = object lessons), it was believed that *vision* was *the* mean of gaining knowledge (Yanni 1999: 31). This applied to art museums as well as natural history museums, and such assumptions had direct effects on the architecture of museums.

The first visual challenge all museum architects had to solve was the problem of lighting: As many objects as possible had to be presented in optimal lighting conditions to help the visitors *see* and hereby *learn*. In natural history museums visual comparison and scrutiny had an even deeper, more crucial importance than in art museums: in the taxonomic exploration of nature, started by Linneaus in the eighteenth century and continuing today, visual comparison was *the key* to the determination of species. The newly established natural history museums aimed to give visitors experiences that allowed them to replicate and thereby understand these visual methods. To achieve this, hundreds of objects were placed next to each other according to their systematic relationship in well-lit showcases.

A second challenge that needed to be solved was the visitors' flow. The arrangement of the exhibition-rooms had to offer the visitors an uninterrupted passage. Through specific traffic flow patterns, museums aimed to produce certain narrative understandings of science with specific progressions: the succession of the rooms and their showcases guided the visitor's gaze, which proposed a certain narrative under which the objects should be viewed. While in art museums, the objects were arranged according to their chronology and to their artistic schools, in natural museums the zoological collections were mostly organized taxonomically in ascending or descending order and the mineralogical collections according to their classification-system.

In addition to lighting and traffic flow, very soon a third question arose: what would be the role of the decorative framework in presenting collections? By 1816 Goethe had already claimed that the exhibition rooms of art history museums should be decorated 'tastefully and analogous to the objects' (Goethe 1816: 11). On the one hand, there was the expectation that the furnishings of the rooms should match the worth of the collections exhibited; on the other hand, however, the décor should not distract the visitors. While in the case of art museums the competition between the artwork on display and the furnishing of the rooms was a central theme for museum designers, this issue of aesthetic competition played almost no role in natural science museums. Here the décor had to tackle a didactic task. In contrast to art museums, the single object in natural history museums was often not very visually appealing, but derived its importance only through its contextualization within the rest of the collection. Learning from taxonomic and systematic presentations was only possible for the trained eye; it became clear, that for lay audiences a new visual dimension had to be incorporated in the collections to make them comprehensible. The importance such of 'visual upgrading' was reinforced as natural history museums came under increasing pressure from other (ephemeral) forms of exhibition that competed for the public's attention (like world exhibitions, science fairs, etc.) Even before the 'biological turn' at the end of the century (Köstering 2003) the need to create different kinds of visualizations led to a hitherto unprecedented number of collaborations between artists and scientists. Only by becoming successful 'visual narrators' could the new natural history museums fulfil their double task of being scientific and educational institutions at the same time. The new natural history museums had to become 'mass media' of science. When I say museums acted as mass media, I mean that the `natural history museums' as scientific and educational institutions not only reached a large public through their visitors (the NHM Vienna reached more than 400,000 visitors just one year after its opening), but that they also reached far beyond their circle of visitors in their role as principal sites for the production of science visualizations (in their decorations, exhibition displays, lectures and also in their scientific journals). As originators and generators of visualizations, the museums influenced much wider audiences than their visitor numbers would imply. Their impact went across social and geographic borders.

Science visualizations in the context of natural history museums

In the context of nineteenth-century natural history museums two types of science visualizations can be distinguished. The first type comprises the production of science visualizations as independent artworks. These could be placed next to the objects in the showcases as didactic add-ons, but could also be removed when outdated. This type was, and still is, very common in Natural History Museums.

The second type is integrated into the actual construction of the Natural History Museums. These are science visualizations which form part of the decorative detail of the museums. The first Natural History Museum to implement this idea of built-in visualizations was the Oxford University museum, which opened in 1860. As shown by John Holmes (2018), the Oxford University museum was a bold experiment in which the artistic movement of the Pre-Raphaelites shaped the architecture of the building, and thereby the way science was studied and communicated to a wider public (see also Holmes, 'Science and the Language of Natural History Museum Architecture,' in this issue). This decorative concept was to become a role model for later natural science museums. In the successive museums, the architecture and furnishings were used as media of spatial storytelling, conveying the exhibition's narratives, although the extent of this approach differed significantly from museum to museum.

However, the fact that scientific visualizations became part of the architecture also created problems for the museum: because the state of scientific knowledge changed continuously, all visualizations had to face being outdated sooner or later. The Oxford University museum's religious imagery, and the separation of living and extinct species in the decoration of the NHM London, are examples for this problem (Yanni 1999: 111-146). Even though their narratives were kept very general, their design and decoration became physical manifestations of an out-dated perspective on nature. One reason for this problem was surely the fact that the construction of such big buildings took many years, sometimes decades. Time was the enemy of scientific representations: being seen as old-fashioned would be a deadly sin for a building devoted to science, since scientific discourse aligned itself with modernity and timelessness as part of its cultural legitimacy (Yanni 1999: 147).

One way of dealing with this problem was for museums to completely refrain from using the architecture for scientific visualizations. The Naturkundemuseum Berlin, for instance, decided to be as modest in its decoration as possible. The architectural design of the exhibition was reduced to the minimum to avoid the problem of anachronism and give the objects the possibility to speak for themselves. The architecture of the museum itself did not integrate any science visualizations; it stayed quiet as 'visual narrator'. As Jutta Helbig (2019) has shown, the content of the showcases was well thought out by the museum's director Karl August Moebius (1825-1908). By enriching them with inscriptions, pictures and models, the interior of the showcases was designed like a textbook. Similarly, the Muséum national d'histoire naturelle in Paris also reduced its decorative design to a few very general topics (such as the struggle for existence) that were addressed mainly in the sculptural decorations on the façade or in the surrounding park area. Compared to these more minimalist examples, the NHM Vienna chose a completely different way. Unlike almost any other museum, it followed the idea of the 'Gesamtkunstwerk', meaning the building was conceived as an entire and single piece of art; the term was coined by Richard Wagner and adopted for architecture by Gottfried Semper. This meant that architectural frame and the artistic content were intimately related to each other. Unlike other natural history museums, the NHM Vienna included not only very general but also very specific scientific visual narratives in its design. It can be understood as the climax to the tradition set out in Oxford. Thanks to its extreme wealth of both built-in and independent science visualizations, the NHM Vienna is a perfect case study for comparing and understanding the functions and the variety of nineteenth-century science visualizations.

As the field of science visualizations in the realm of the natural history museums is extremely vast, I will make a first attempt to introduce a categorization-system according to the main purposes. In my eyes, these can be reduced to five main tasks, which are: 1. Documentation, 2. Reconstruction, 3. Enlivenment, 4. Reflection and 5. Imagination. For each one of these tasks I will present selected examples and examine their function in the museum as 'visual narrator'.

1. Documentation – *Pictures of the World*

The documentation of places and realms yet unknown to the general public was one of the primary tasks of nineteenth-century scientific visualization. The public's desire to see new worlds seemed almost insatiable. Although the invention of photography around the middle of the century created new documentary standards, the images produced by photography missed one important aspect - colour. Colour information could still only be provided by painting and, after 1837, by chromolithography. A statement by Franz Toula in the Viennese journal *Neue Freie Presse* from 23 February 1881 illustrates this problem:

> For a time, the development of photographic landscape depictions has placed photography in the foreground with images that are easy and relatively cheap to acquire; yet in more recent times one has felt the need to resort to the production of images in colours. The photographic images, with their truthfulness, provide the invaluable material, but the technical perfection that colour printing has brought, made it now possible to produce such images that satisfy all requirements. (Toula 1881: 20)

This quote shows clearly the important function photography had in documenting reality: the simple image served as an assistive tool, but it required the addition of colours to document the world *as it really is*. Especially in the context of natural history museums, the information provided by colour became very important for enhancing the exhibition's outreach. This is underpinned by a statement from the German geographer Emil Deckert (1848-1916) who wrote about the paintings by the seventeenth-century Dutch portrait painter Albert Eckhout in the Ethnographic Museum Copenhagen:

> Eckhout's paintings show nicely how the art of the painter can help ethnography, by depicting people in their natural surrounding especially in the genuine colours in which he lives, this in advantageous opposition to photography. (Images by Eckhout on the website of the Nationalmuseet Copenhagen, http://eckhout.natmus.dk/gallery.shtml, accessed 18 June 2019) (Deckert 1878: 10-12)

As an example of this painterly advantage that can be found in the NHM Vienna I want to present one painting that is incorporated into the museum's architecture as part of a frieze consisting of more than 100 pictures. The paintings of this frieze should document the places of origin of the displayed collection-specimens. In the mineralogical department, for example, they would mainly present important mining sites within the Austro-Hungarian Empire. The artists commissioned for these paintings were asked to create images as naturalistic as possible (Jovanovic-Kruspel 2014). Either they would be sent to the place itself to take first hand sketches or, if that was too expensive, they would be provided with photographic or other templates selected by the curators of the museum. The painting in this example shows the famous 'Postojna Cave', a large karst cave in south western Slovenia. Created by the Austrian landscape painter Carl Hasch (1834-1897) it was completed by 28 April 1883 at the latest (as Carl Hasch submitted his invoice on that date (Allgemeines Verwaltungsarchiv, Stadterweiterungsfond, 29, 7858).

Fig. 1: Carl Hasch: Adelsberger Grotte (Postojna Cave), NHM Vienna, photo: A. Schumacher

Fig. 2: Postojna cave, school wall chart from the series Geographische Charakterbilder *Ed. Hölzel, photo: A. Schumacher*

This painting was mounted in the exhibition room where stalactites of the same cave were on display. The picture shows the interior of the cave, which was very popular with tourists, including its variety of stalactites illuminated by men with torches. In the year 1884 (five years before the museum opened in 1889) a chromolithographic reproduction of this painting was published as part of a series of school wall charts under the title *Geographische Charakterbilder* (geographical characteristic pictures) by the publishing house Eduard Hölzel (Anonymous 1884). by Eduard Hölzel, after Carl Hasch's painting; photo: A. Schumacher

As Hölzel emphasized in an advertisement, the picture was made with permission of the director of the NHM Vienna, Ferdinand von Hochstetter (1829-1884), after nature sketches by Carl Hasch also made on behalf of Hochstetter (Hölzel 1883).

This painting from the museum's decoration is not the only one that influenced the series of school wall charts designed by Eduard Hölzel (Jovanovic-Kruspel 2019). There are many overlaps between the museum's frieze of paintings and these extremely popular school wall charts. A large number of topics of the museum's paintings inspired such wall charts; sometimes they are, indeed, almost identical (like in the Postojna cave), or they show the same location just from a slightly different angle, or they chose a similar sight in a neighbouring locality. The series *Geographische Charakterbilder* by Hölzel had an extremely high circulation and was sold worldwide. Their images were widely distributed as teaching tools, but also as room decorations with didactic claim. Hölzel explicitly promoted these pictures as wall decorations in work- and study-rooms for the educated middle class. Hölzel's aim was to combine high-quality artistic landscape painting with scientific content – in this case with geography. This combination of art and science corresponded to Hochstetter's ambitions for the museum's picture programme, which he aimed to establish the museum as a place of education and visual instruction for everyone (Hochstetter 1884). The paintings therefore were designed as teaching tools and decorations at the same time. As the example of the Postojna cave illustrates, there is much to suggest that Hochstetter's picture frieze for the NHM was an important inspiration for Hölzel's series of geographical characteristic pictures (Jovanovic-Kruspel 2019). The fact that the landscapes created and selected for the museum were then disseminated by Hölzel's wall charts into the school system and even into bourgeoise households underlines their importance in popular science culture. This transfer enabled the museum, as the co-creator of this scientific imagery, to extend its influence far beyond the mere circle of visitors. The museum's function transformed from 'visual narrator' to 'visual teacher'. The pictorial motifs created in this context influenced the emergence of a collective visual memory, and hence, participated as a form of mass media. This produced a canon of image-worthy landscapes typical for certain regions of the world that is still influential today, and that shaped the European perception of the world.

2. Reconstruction – *Accuracy or fantasy?*

The second purpose science visualization had to perform in the context of natural history museums was 'reconstruction'. Georges Cuvier's reconstructions of extinct animals had caught the imagination of the whole educated world (Rudwick 1992: 30). This fascination with the primeval world led to successively better reconstructions and the natural history museums, with their rich fossil collections, were the perfect communities for this work. But the earliest reconstructions of prehistoric life were only two-dimensional. Benjamin Waterhouse Hawkins (1807-1899) created the first 3D reconstructions of fossilised animals. In close collaboration with the anatomist Richard Owen (1804-1892) he designed the first life-sized 3D reconstructions of dinosaurs for the grounds of the Crystal Palace in Sydenham (opened in 1854). His 'antediluvian monsters' became a role model in this new field of paleo-art (see also Kistler and Tattersdill, 'What's Your Dinosaur?', in this issue).

In the NHM Vienna paleontological caryatids by Rudolf Weyr (1847-1914) were incorporated into the museum's decorative scheme almost 30 years after Sydenham's Crystal Palace dinosaurs. A series of sculptures (caryatids = figures half-human and half-pilaster) including reconstructions based on fossils created by Rudolf Weyr illustrates the evolution of plants and animals during earth's history over the last 500 million years. Unlike Hawkins, who strived to represent dinosaurs with an eye to scientific accuracy, Weyr did not want to visualise any specific theory but sought his own artistic and poetic approach. Any attempt to read Weyr's series as a visualization of a specific scientific theory of development (formulated by Lamarck or Darwin) fails. The 24 male and female figures are bearing extinct animals and plants as attributes. One of them presents an ichthyosaur-reconstruction that deserves closer examination (see Jovanovic-Kruspel 2014).

Fig. 3: Rudolf Weyr: caryatid of an ichthyosaur, NHM Vienna, photo: A. Schumacher.

This depiction of an ichthyosaur is scientifically inaccurate, even by the standards of the time when it was created, but perhaps for some interesting reasons that speak to the complexity of the purposes of scientific visualizations. The first depicted reconstructions of ichthyosaurs show these animals as sea-dragons with pointed lizard tails. The frontispiece of Thomas Hawkins' *Memoirs of ichthyosauri and plesiosauri* shows how this animal was reconstructed in 1834 (Hawkins 1843: frontispiece). However already in 1838 Richard Owen noticed that the fossilised skeletons of the ichthyosauri all had a peculiar break in the vertebral column - always in the same position. Owen interpreted, that on this place there must have been a small fleshy tail fin. This reconstruction was also the basis for the 3D-ichthyosaur created by B. W. Hawkins in the 1850s for Sydenham. Ferdinand von Hochstetter also adopted Owen's reconstruction of the small tail fin in his illustrated children's book *Geologische Bilder der Vorwelt und der Jetztwelt* (Geological pictures of the primeval world and today) from 1873. There he included an illustration of an ichthyosaur showing the same form of tail fin as in Sydenham. The explanation of the illustration said: 'The extremities are in the form of fins or oars made up of many polygonal bones, and the long tail probably ended with a wide upright tail fin' (Hochstetter 1873: 11). The true form of the tail of the ichthyosaur as we know it today was not realised before 1892, when a well-preserved skeleton with a carbonised impression of the body outline was found in the grained Lias sediments of Holzmaden in Germany (Howe et al. 1981: 25). Since then it was clear that the ichthyosaur resembled more a dolphin with a dorsal and a clear-cut tail fin. However, Weyr's ichthyosaur (from the 1880s) astonishingly still resembles the sea dragon with a lizard tail by Thomas Hawkins (1834).

The caryatid obviously sticks to the then already 50 years out-dated version of the sea dragon. It has to be assumed that this did not go unnoticed by the scientists of the museum. Even though Hochstetter died in 1884, before the caryatids were completed in 1885, there were other scientists involved who must have known the latest state of science. Franz Hauer, Hochstetter's successor as director of the museum, was a geologist himself. He and Dionysius Stur, the director of the Geological Survey, were directly involved and supervised the decorative program. The only explanation for the caryatid's design is a conscious form of 'historicism'. It seems that Weyr took the decision to stick to an already old-fashioned form of representation, thus avoiding being out-dated by the fast progress of science and the scientists involved supported this decision. By doing so Weyr opened the beholder's imagination to the world of fantasy rather than to scientific accuracy. It seems that Weyr's aim was to use the caryatids to arouse curiosity and fascination for science rather than conveying the latest state of knowledge. As the caryatid belongs to the category of built-in science visualization Weyr had to accept that it was very likely that scientific progress would outdate his creation and that there would be no chance of adapting or removing it. He therefore deliberately took a historicist approach to avoid the problem of potential anachronism. This example shows impressively that science visualization is not always about being completely scientifically accurate and up to date and historicism is a potential way out of the conundrums of anachronism.

3. Enlivenment – *True to life*

A third purpose of science visualization is 'enlivenment'. The fact that natural history museums were restricted to showing only lifeless things was a problem that became especially virulent with objects that could not be preserved in their original appearance like corals, jellyfish or molluscs. As soon as corals dried they lost their colours, and jellyfish and molluscs could only be preserved in alcohol, which also paled their colours. But for museums the presentation of animals in forms as life-like as possible was very important to fulfilling their task of visual education. One way of solving this problem was, as I have already discussed, photographic representation. But apart from the aforementioned problem of being only black and white, photography had additional limits in capturing animals in motion. Due to the very long exposure times, it was difficult to take accurate photographs of living - and moving - animals, and the technique of motion picture film was not yet invented. So, again the skills of the painter were in demand. Eugen von Ransonnet-Villez (1838–1926) was an Austrian artist-explorer who dedicated his life to visually documenting the then-unknown underwater world. Public interest in the underwater world had peaked around mid-century. In 1853 Philipp Henry Gosse's (1810–1888) book *The Aquarium* had become a real bestseller and had led to a 'craze for aquariums'. In 1860 the first

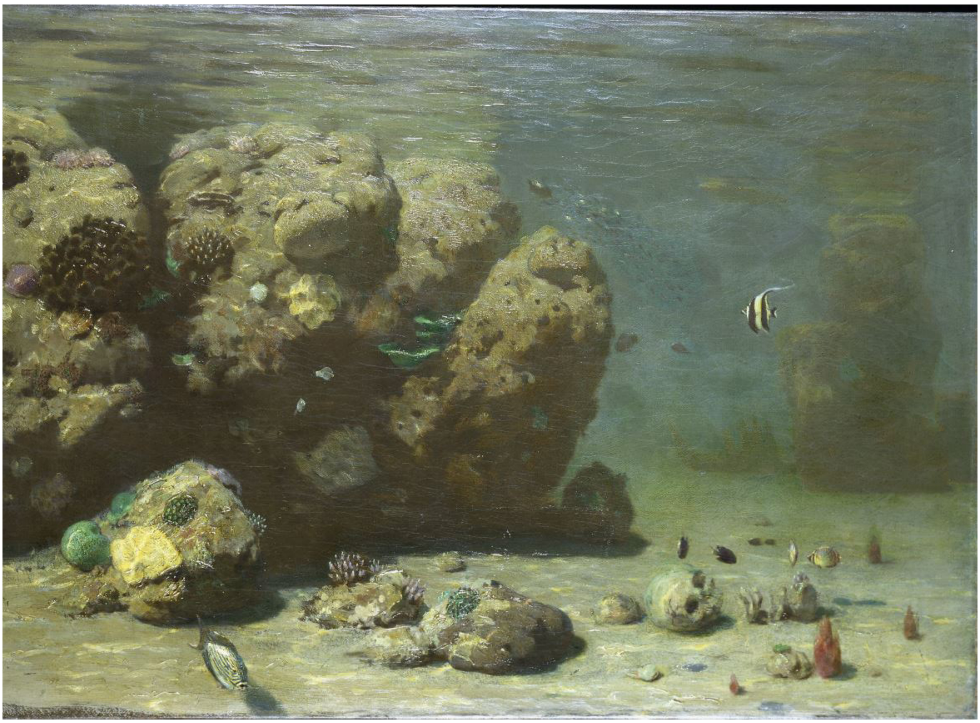

Fig. 4: Eugen von Ransonnet-Villez: Underwater oilpainting, before 1892, NHM Vienna, photo: A. Schumacher

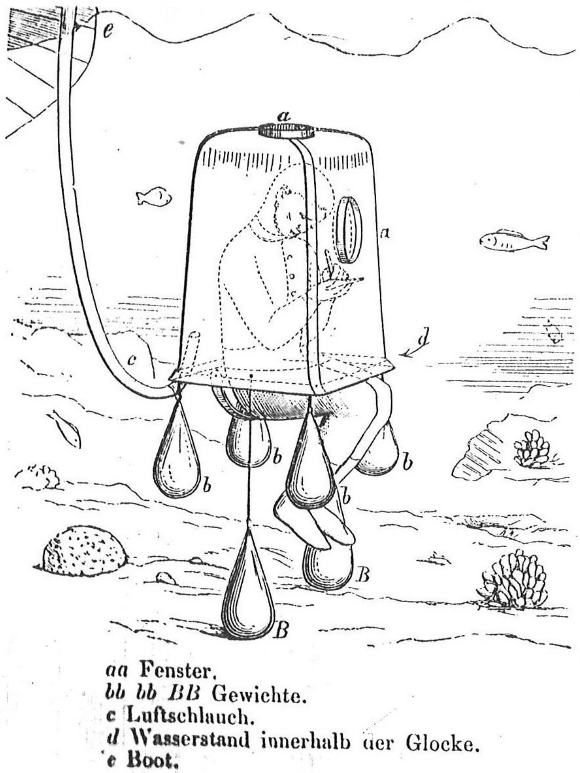

Fig. 5: Eugen von Ransonnet-Villze: the diving bell, illustration from: Ceylon. Skizzen seiner Bewohner, seines Thier- und Pflanzenlebens und Untersuchungen des Meeresgrundes nahe der Küste, Braunschweig, 1868; libraries, NHM Vienna.

public salt water aquarium on European mainland opened in Vienna, Ransonnet's home town (Brunner 2005: 104). In 1892-93 Ransonnet donated an underwater-oil painting to the NHM Vienna (Hauer 1893: 5). This picture tackled both problems photography had then: it captured the colours of the corals in their natural environment and on the other the movement of the waves, as well as the motions of the light reflexes and the swimming fish. Ransonnet had travelled to Ceylon (today: Sri Lanka) in 1864-65 (Jovanovic-Kruspel *et al.* 2017; Jovanovic-Kruspel and Pisani 2019). Using a diving bell designed by himself, he observed and sketched the underwater world. Ransonnet's diving bell experiment in Ceylon is surely one of the unrivalled pinnacles of nineteenth-century underwater exploration. He described the design and trials of the diving bell elaborately in his book *Sketches of Ceylon* (Ransonnet-Villez 1867). The painting he gave to the NHM Viennna was based on sketches that he had done in Ceylon 1864-65. For Ransonnet, it was very important that every detail of his picture was accurately documented and true to life.

Ransonnet's painting had a clear didactic purpose. In conjunction with the dried, pale corals in the museum exhibits, the painting provided the visitors with more accurate information on how they looked in real life. It was Ransonnet's aim to take the beholder under water. Virtually swimming among with the fish, the visitor would visually access this living environment through art. Ransonnet also produced other underwater images for scientific textbooks. For Kerner von Marilaun's first volume of his book *Pflanzenleben* (life of plants) Ransonnet contributed two illustrations with underwater landscapes from the Adriatic sea. In the illustration *The nullipor benches in the Adriatic Sea* he also included floating salps. The general fascination with the underwater world generated also a deeper interest in the biology of marine plants and animals.

Salps and other marine invertebrates that as dead specimens lose essential information like colour, motion, and form were also represented in a life-like and at the same time artistic way by glass models produced by Leopold (1822-1895) and Rudolf Blaschka (1857-1939).

Between 1863 and 1890 the Blaschkas sold their models as educational aids to museums, schools and universities all over the world. The NHM Vienna possessed some of these models for their exhibitions (Hauer 1889: 210). The wealthy Viennese industrialist Richard von Drasche-Wartinberg (1850-1923) donated them to the museum in 1885. In the first guide book of the museum they were described thus: 'Although extraordinary progress has been made in the conservation of these predominantly gelatinous forms by the zoological station in Naples,

Fig. 6: R. and L. Blaschka, glass model of Rhizostoma pulmo*, NHM Vienna, photo: A.Schumacher.*

the vividness of smaller objects in particular is considerably enhanced by models' (Hauer 1889: 210). As Reiling (1998: 107) has discussed, the 'aquarian movement' helped to create a market for this kind of model; many of the early models were based on the illustrations by Philipp Henri Gosse (1810-1888). The Blaschkas' models underwent an artistic development in the process of their manufacturing methods: from copying scientific illustrations, the Blaschkas eventually started to work directly with zoologists, until they became the exclusive designers of their glass models. These models reached an 'incredible degree of perfection' and in their stylistic language they referenced Ernst Haeckel and the early Jugendstil. The Blaschkas' models were in demand all over the world (Reiling 1998: 126). They offered 'the paradox of rendering soft animal tissues in hard inorganic material, thus transcending both animal life and the properties of glass' (Reiling 1998: 126). Pictures and models like those of the Blaschkas and Ransonnet are border-crossers between art and science. Their task was to enliven the zoological exhibition, that otherwise resembled a 'dead zoo'. Only art had the means to represent certain organisms in their biological environment.

4. Reflection – *On the history of science*

The next purpose science visualization had to fulfil can be conceptualize under the term 'reflection'. Most natural history museums of the nineteenth century used their decorative programs to reflect on the history of science as such. The most common way of integrating a historic discourse about science was the incorporation of statues or busts of scientists. In the Oxford University Museum, for example, prominent life size statues of scientists surround the central court; 'The great Founders and Improvers of Natural Knowledge' were represented by 'modern' and 'ancient' scientists (Holmes 2018). These included Aristotle, Hippocrates, Bacon, Galileo, Newton, Leibniz and Linnaeus. In the Naturkundemuseum Berlin, the statues of Leopold von Buch and Johannes Müller flank the entrance and above three medallions that show the portraits of Christian Gottfried Ehrenberg, Alexander von Humboldt and Christian Samuel Weiss. In contrast to Oxford, where the scientists were international and from different time periods, in Berlin the selection of scientists is limited to the Humboldtian era and only German scientists were presented on the façade. In Vienna, the idea of presenting history of science through the presentation of researchers included both the international and the local context. On the façade of the building, a chronological series of international scientists from ancient times up to the time of the museum's opening were presented in the form of statues and portrait busts. Inside the museum the statues around the main staircase repeated this idea. But apart from this international chronology the NHM Vienna also incorporated portrait medallions of 'local' scientists. This way, the NHM Vienna paid tribute not only to the international dimension of scientific progress in history, but also to the contribution its own researchers had made in enriching the museum's collections.

However, in Vienna this 'historicist' approach on science was not limited to the topic of the researchers. The caryatid program in the mineralogical department, by the Austrian sculptor Rudolf Weyr (who also created the already described prehistoric animals such as the ichthyosaur), takes this idea of historicism even further: instead of representing 'modern mineralogical science' Weyr chose a historical approach, in which he made the already outdated scientific idea of alchemy the core message of his decorative program. The caryatids symbolize different metals and minerals, which were the materials alchemists worked with (Jovanovic-Kruspel 2014). The Austrian imperial court had a long tradition of both collecting minerals and experimenting in alchemy; therefore, the history of the mineral collections is intertwined with the alchemical history of the court. Well-known examples of this are the transmutation experiments of Leopold I in the 1770s. Emperor Franz Stephan (1708-1765), the founder of the museum's collections, was also famous for his alchemical experiments (e.g. the attempt to melt diamonds to make larger ones). The history of the mineralogical court collections and the alchemical ambitions of the emperors are inseparable. Among others, five figures represent the metals, tin, copper, iron, silver and lead. These figures contain alchemical symbols and thus reflect the history of the mineralogical collection, which had its roots in the chambers of wonder and curiosity. The Rudolf Weyr's caryatids play with this historical reference. The assignment of metals to the powers of planets and gods corresponded to the alchemical natural philosophy that was thought to pervade the cosmos. As examples, I want to present two pairs of caryatids, tin and copper and iron and lead in more detail.

Fig. 7: Rudolf Weyr: caryatids of Tin & Copper, around 1885, NHM Vienna, photo: A. Schumacher

Fig. 8: Rudolf Weyr: caryatids of Iron & Lead, around 1885, NHM Vienna, photo: A. Schumacher

The metal tin is represented by a male sculpture with a tin plate in his hand, on which can be seen the symbol of the planet Jupiter. The mineral on the stump of the caryatid is based on a specific specimen of the collection, the cassiterite (tin dioxide) from Schlaggenwald (today Horní Slavkov) in the Czech Republic. The woman next to him symbolizes copper. At the base of this figure is the most important copper mineral, chalcopyrite (yellow copper ore). The clasp on her breast carries the symbol of the planet or goddess Venus (♀). The two figures of copper and tin hold hands symbolizing the oldest known metal alloy (bronze), which was already used to produce weapons and utensils in prehistoric times (the Bronze Age). This reference is reinforced by the bronze statuette held in the hand of the female figure.

The caryatid for iron is a man armed with a spear and a morning star. He carries the symbol of the god of war and the planet Mars (♂) on his breastplate. On the stump of the caryatid is remodelled the mineral sparry siderite, from which iron was extracted at that time. An old woman next to him with a snake in her hair symbolizes lead. She is pouring the liquid metal into a container with a ladle. On the stump of the caryatid is galena (lead sulphide). A mineral specimen from Neudorf im Harz in Germany, supposedly served as a model for this. The planet Saturn is associated with lead and, like the Greek god Chronos, stands for the principle of creating life and destroying it again (cf. Goya's famous painting *Saturn eats one of his children* in the Prado in Madrid). The symbol of the planet Saturn is on the stump of the caryatid.

This combination of alchemical symbols and authentic representations of specimens from the collection in the caryatids makes them border-crossers between authenticity and historicism. The reference to the alchemical worldview shows that the decorative program also had the purpose to reflect on historic attempts of world explanation. The visitor was made aware of the origins of the collections and at the same time, that scientific knowledge was in continuous flux.

Imagination – *symbols and allegories: beyond knowing*

The most sophisticated purpose of science visualization is the translation of complex scientific theories into pictorial representations. The translation of Darwin's theory of evolution into images was one of the great challenges in the intellectual discourse after 1859. Whereas the NHM Vienna's forerunner, the Oxford University Museum, was still strongly influenced by William Paley's *Natural Philosophy* and therefore not only alludes to religious buildings in its architectural language, but also integrates biblical motifs into its decorations, the NHM Vienna (opened 29 years after Oxford) turned away a religious interpretation of natural sciences and tried to integrate a Darwinian narrative into the museum's decoration. To tackle this task Darwin's theory had to be reduced to images that had to stand as *pars pro toto* for the whole theory. The NHM Vienna addressed this theory mainly in two artworks, each focusing on a different aspect. The so-called 'Darwin Frieze' by Johannes Benk deals with the origin of man, and *The Cycle of Life* by Hans Canon concentrates on natural selection through the struggle for existence.

Even though Darwin avoided discussing the question of humanity's relation to apes for a long time, the visualization of his theory tended to focus on this special matter almost immediately after the publication of *Origin of Species*. As Julia Voss has shown, the snarling gorilla first published in a French museum's journal in 1858 became the grim pictorial impersonation of the evolutionary parent (2007: 291-313). The popular pictorial language related to Darwin's Theory of Evolution circled around this topos of man and ape: the decorative program of the NHM Vienna was no exception to this. However, contrary to a grim gorilla, the NHM Vienna chose a cheeky chimpanzee to hint its visitors to the 'truth' they had to face.

Fig. 9: Johannes Benk: Darwin-Scene, before 1889, upper dome, NHM, photo: A. Schumacher

The Darwin-scene forms part of a frieze in the great snap ring of the dome of the museum by the sculptor Johannes Benk. In this frieze, scenes between animals and young boys are set in a series of tendril loops. On 3 September 1888 Johannes Benk received the commission to produce a 'frieze in gypsum, with animal figures, emblems and ornaments.' On 16 January 1889, the sculptor submitted his invoice for this work (Allgemeines Verwaltungsarchiv, Stadterweiterungsfond, 275, Fasc. 29, 1889, 16 January). In one of the scenes ultimately produced, a chimpanzee holds a mirror in front of a boy who covers his eyes because he does not want to see his reflection. A contemporary art critic described this scene as follows:

> The head of an ape takes the center of the fifth strip, which is a lively composition; on the left, a grinning ape holds a mirror in which a boy shamefully recognizes his similarity to the ape; in addition we see a monkey with an open book on which the words: 'Darwin, The Descent of Man' are engraved (Nossig 1889: 456).

The contemporary description cited here takes up the issue of the 'Darwinian insult' in a striking way: 'shamefully', the boy in the scene – and the visitor to the museum – have to accept their origin that connects them to animals. But Benk softened the explosive nature of the message through a comic approach. With the help of humor, the sharpness of the statement was minimized.

Another topic that immediately came into the focus of visualizations around Darwin's Theory of Evolution was the 'struggle for existence'. The passage in Darwin reads:

> Hence, as more individuals are produced than can possibly survive, there must in every case be a Struggle for Existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical conditions of life. (Darwin 1859: 63, chapter 3; http://darwin-online.org.uk; accessed 17.5.2019)

Fig. 10: Emmanuel Fremiet, Orangutan strangling a Borneo savage, 1896, Gallery of Palaeontology, Paris; photo: S. Jovanovic-Kruspel

It was a very common simplification by Darwin's interpreters to condense the idea to the struggle between two organisms in which the physically superior wins (Voss 2007: 328). This kind of simplification is also seen in the decorations of the Gallery of Paleontology in Paris and its surrounding park, where the sculptures on the façade and in the park focus on the fight between man and beast. Remarkably, in none of the sculptures this fight is easily won by man: in Fremiet's sculpture the confrontation between ape and man, for example, the human is defeated.

The theme of struggle is revisited in NHM Vienna in Hans Canon's painting, *The Cycle of Life*, which forms the center piece of the museum's decoration. Canon was left to freely decide the content of the painting - another example of how artistic freedom was of the utmost importance in commissioning the museum's decorative elements. Canon wanted to show the 'rise and fall of human life in its connection to the development of the natural sciences' (Drewes 1994: 330). He focused on the fate of mankind in his *Cycle of Life*. In a letter he wrote about his work:

> The painting on the ceiling conveys the cycle of life. Under a bridge of stacked boulders, the sphinx rests in the darkness on a stone covering the ground. On the viewer's right, young life springs up. Children, young girls, young boys, men and women strain upwards, together with other figures, striving for nourishment, fame, goodness and power. In the middle of the arc, two knights are fighting, one winning, one falling. Decline, loss of goods, and sinking to death complete the arc on the left. Flowers, blossoms, green trees and an eagle with a laurel are on the right; a fir tree struck by lightning and a vulture standing on a corpse are on the left. In the foreground, a brooding figure, thinking how the mystery can be solved (cited by Drewes 1994: 330).

The cycle of growing, fighting and passing away in human existence can surely be interpreted as an allusion to Darwin's 'struggle for existence'. But this is at the same time much more than this. Allegoric and symbolic elements like the Sphinx with a sealed book, or the man with the hourglass, open the picture's interpretation to diverse meanings and to a hidden truth that lies beyond this fight for survival.

The museums of the nineteenth century, as 'temples' of the modern world, were not only places of knowledge and education, but also places of transcendent self-reflection and self-location. The use of the stylistic devices allegory and symbol - tools used for centuries by art to make the invisible visible - is an artistic response to this task of creating the museum as a place of transcendence. Many natural history museums included this allegoric and symbolic layer in their decoration programme, but at the NHM Vienna this dimension had central importance. Through the inclusion of symbols and allegories, the decorative program was consciously kept open for different interpretations beyond the representation of factual scientific knowledge, which was important as it had to bridge the expectations and desires of diverse and often even conflicting social groups. The combination of diverse narratives circling around the questions of knowledge and truth made the museum a polyphonic orchestra of ideas leaving room to negotiate the 'idea of truth'.

Fig. 11: Hans Canon, The Cycle of Life, 1884, NHM Vienna, photo: A. Schumacher

Conclusion

The examples presented here can only show a small part of the great variety of the phenomenon of science visualizations in the context of natural history museums. Nevertheless, they let us see these institutions in a new light. As all examples illustrate, the newly built natural history museums of the nineteenth century provided a fertile ground for the creation of different kinds of science visualization, even integrated in the architectural fabric of the buildings. These visualizations reached out to wide and very diverse audiences. As the connections between the paintings at the NHM Vienna, the school wallcharts, and also the highly popular Blaschka glass models show, the imagery created and used in the context of the natural history museums found a very wide dissemination beyond the confines of the original buildings. With their images created to convey scientific information and ideas, the natural history museums reached out into the educative system and into society at large. The wallchart series of *Geographische Charakterbilder* by Eduard Hölzel is just one example for how the museum's imagery found its way out of the confines of the institution. As shown in an earlier paper the decorative paintings of the museum were even exported via photography to Mexico (Jovanovic-Kruspel and Olivares 2017). Nevertheless, the series of *Geographische Charakterbilder* is of special interest as it not only illustrates the cross-fertilizing effects of the museum's program into the educative system and the private households but it also sheds light on a much vaster process of the development of a collective visual memory.

Through the selection of important motifs of geographically or geologically 'typical' and significant landscapes (Anonymous 1882), or through the reconstructions of unknown worlds like prehistoric landscapes, animals and plants, the science visualizations produced by, for, and within natural history museums shaped our collective visual consciousness. In this context, scientific accuracy and correctness were of great importance, but they were – as could be shown – not the only requirements. The 'visual histories' told by the museums found their main purpose in fuelling the audience's imagination and inspiring them to imagine beyond the known universe. As sites of collective representation, reflection and re-definition, the museums aimed to leave the confines of the already known. Two years before his appointment as director of the NHM Vienna Hochstetter described the progress of the sciences in a way that illustrates where this process should lead:

> In the continuation of scientific understanding, sometimes the idea of space, sometimes the idea of time, expands and the fast progress of research pushes the horizon always further out, until thought arrives at that point where it stands still – in the premonition of infinity. (Hochstetter 1874: 260).

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Bibliography

Anonymous (1882) 'Hölzels geographische Charakterbilder', *Zeitschrift für Schulgeographie*, Wien 1882, III. Jahrgang, 242-243.

Anonymous (1884) 'Hölzels geographische Charakterbilder', *Zeitschrift für Schulgeographie*, Wien 1884, V. Jahrgang, 127-128.

Brunner, B. (2005) *The Ocean at Home, An Illustrated History of the Aquarium*, New York: Princeton University Press.

Brückner, W. (1973) *Die Bilderfabrik, Dokumentation zur Kunst- und Sozialgeschichte der industriellen Wandschmuckherstellung zwischen 1845 und 1973 am Beispiel eines Großunternehmens*, Frankfurt am Main: Franz Jos. Henrich KG.

Deckert, E. (1878) 'Die ethnographischen Museen', *Allgemeine Zeitung*, München, 1878, 27 March 1878, 10-12.

Drewes, F. J. (1994) *Hans Canon 1829-1885, Werkverzeichnis und Monographie*, Studien zur Kunstgeschichte (84), Hildesheim, Zürich, New York.

Friedrichsen, L. (1881) *Süd-See Typen. Anthropologisches Album des Museums Godeffroy in Hamburg*, Hamburg: L. Friedrichsen & Co.

Goethe, J. W. v. (1816) Über Kunst und Altertum in den Rhein- und Maingegenden (vol. 1), Stuttgart.

Gosse, P. H. (1853) *The Aquarium: An unveiling of the Wonders of the Deep Sea*, London: John Van Voorst, Paternoster Row.

Hauer, F. v. (1893) 'Notizen', *Annalen des k. k. Naturhistorischen Hofmuseums* (8) 5.

Hawkins, T. (1834) *Memoirs of ichthyosauri and plesiosauri, extinct monsters of the ancient earth with 28 plates copied from specimens in the author's collection of fossil organic remains*, London: Relfe and Fletcher.

Helbig, J. (2019) *Das Berliner Museum für Naturkunde, Bauen und Ausstellen im Spiegel der Museumsreform – eine Konfliktgeschichte*, Baden-Baden: Tectum-Verlag.

Hochstetter, F. v. (1873) *Geologische Bilder der Vorwelt und der Jetztwelt. Zum Anschauungs-Unterricht und zur Belehrung in Schule und Familie*, Esslingen: Schreiber Verlag.

Hochstetter, F. v. (1874) 'Die Fortschritte der Geologie', *Vortrag gehalten bei der feierlichen Sitzung der kaiserlichen Akademie der Wissenschaften*, 30 May 1874: 229-260.

Hochstetter, F. v. (1884) 'Das k. k. Hof-Mineraliencabinet in Wien', *Jahrbuch der Geologischen Bundesanstalt* (34) 263-298.

Holmes, J. (2018) *The Pre-Raphaelites and Science*, New Haven and London: Yale University Press.

Hölzel, E. (1883) 'Hölzel's Geographische Charakterbilder', Österreichische Buchhändler-Correspondenz (9) 91.

Howe, S.R., Sharpe, T. and Torrens, H. S. (1981) *Ichthyosaur: A History of Fossil 'sea-dragons'*, Cardiff: National Museum of Wales.

Jovanovic-Kruspel, S. and Olivares, O. (2017) 'The primeval world by the Austrian painter Josef Hoffmann (1831-1904) – A cross over between art and science and its export to Mexico', *Jahrbuch der Geologischen Bundesanstalt*, Wien (157) 269-299.

Jovanovic-Kruspel, S., Pisani, V. and Hantschk, A. (2017) 'Under water- Between Science and Art – The rediscovery of the first underwatersketches by Eugen von Ransonnet-Villez (1838-1926)', *Annalen des Naturhistorischen Museums in Wien*, Serie A (119) 131-153.

Jovanovic-Kruspel, S. and Pisani, V. (2019) 'Among Fish, The life of the Austrian artist and underwater-explorer Eugen von Ransonnet-Villez (1838-1926)', *The International Journal of Diving History* (11) 63-83.

Jovanovic-Kruspel, S. (2014) *Das Naturhistorische Museum, Baugeschichte, Konzeption & Architektur*, Wien: Verlag NHM Wien.

(2019) 'Bilder der Welt: Hölzels "Geographische Charakterbilder" zwischen Museum, Schule und Wohnzimmer',in Barbara Wiesinger (ed) *Innovation aus Tradition, 175 Jahre Verlag Eduard Hölzel*, Wien: Ed. Hölzel.

Kerner von Marilaun, A. (1887) *Pflanzenleben, Vol. 1, Gestalt und Leben der Pflanze*, Leipzig: Verlag des Bibliographischen Instituts.

Köstering, S. (2003) *Natur zum Anschauen, Das Naturkundemuseum des deutschen Kaiserreichs 1871-1914*, Köln, Weimar, Wien: Böhlau.

Lightman, B. (2012) 'Victorian science and popular visual culture', *Early Popular Visual Culture*, 10: 1, 1-5, DOI: 10.1080/17460654.2012.637389

Nossig, A. (1889) 'Das Innere des naturhistorischen Hofmuseums', *Allgemeine Kunst-Chronik, Illustrierte Zeitschrift für Kunst, Kunstgewerbe, Musik, Theater und Literatur,* XIII, 16, Vienna: 451-458.

Paley, W. (1809) *Natural Philosophy or Evidences of the Existence and Attributes of the Deity. Collected from the Appearances of Nature*, twelfth edition, London: J. Faulder.

Ransonnet-Villez, E. v. (1867) *Sketches of the inhabitants, animal life and vegetation in the lowlands and high mountains of Ceylon as well as of the submarine scenery near the coast, taken in a diving bell*, Vienna: Gerold & Robert Hardwicke London.

Ransonnet-Villez, E. v. (1868) *Ceylon, Skizzen seiner Bewohner, seines Thier- und Pflanzenlebens und Untersuchungen des Meeresgrundes nahe der Küste*, Braunschweig: Verlag G. Westermann.

Reiling, H (1998) 'The Blaschka's Glass Animal Models: Origins of Design', *Journal of Glass Studies*, vol. 40, Corning NY: Corning Museum of Glass: 105-126.

Rudwick, M. J. S. (1992) *Scenes from Deep Time*, Chicago and London: The University of Chicago Press.

Stöcker, K. (2018) *Medialisiertes Vermittlungswissen - Untersuchung der Wandbilder zum Anschauungsunterricht und ihrer Begleittexte im Zeitraum 1872 bis 1914*, Bad Heilbrunn: Verlag Julius Klinkhardt.

Toula, F. (1881) 'Hölzel's Geographische Charakterbilder', *Neue Freie Presse*, 23.2.1881: 20.

Uphoff, K. (2002) *Der künstlerische Schulwandschmuck im Spannungsfeld von Kunst und Pädagogik – eine Rekonstruktion und kritische Analyse der Deutschen Bilderschmuckbewegung Anfang des 20. Jahrhunderts*, Würzburg (Dissertation) Julius- Maximilians-Universität.

Voss, J. (2007) *Darwins Bilder. Ansichten der Evolutionstheorie 1837-1874*, Frankfurt am Main: Fischer Verlag.

Yanni, C. (1999) *Nature's Museums: Victorian Science and the Architecture of Display*, Baltimore: Johns Hopkins University Press.

Archival sources:

Allgemeines Verwaltungsarchiv (Austrian General State Archive):
Stadterweiterungsfond, 29, 7858
Stadterweiterungsfond, 275, Fasc. 29, 1889, 16 January

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