



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

GEORGIA AUGUSTA

Research Magazine
of the University of Göttingen

275
JAHRE

COLLECTIONS – WISDOM, INSIGHT, INNOVATION

Issue 8 · December 2011

Published by the University of Göttingen in cooperation with the Universitätsbund Göttingen

IMPRINT

- Publisher:** The President of the University of Göttingen
in cooperation with the Univesitätsbund Göttingen e.V.
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- Design and Layout:** Rothe Grafik, Georgsmarienhütte
- Printing:** Druckhaus Fromm
- Circulation:** 4,000 copies
- Attributed contributions reflect the opinion
of their respective authors and not necessarily that
of the publisher or editors
- ISSN 0016-8157

Foreword

The beginnings of Göttingen University and the development of its faculties and disciplines were closely linked with the conviction that material objects held an important key to scientific understanding. Minerals, skulls, dried plants, unfamiliar animals and the ceremonial and decorative objects of distant peoples found their way to Göttingen and were assembled into a diverse and wondrous library. These exotic bounties became our original 'objects of knowledge'.

But do these objects still have scientific value – do they offer us wisdom, insight and innovation even today? With this issue of our research magazine we would like to offer some evidence that they certainly do. Research on children's literature is as cutting-edge as the DNA analysis of old bones or plants. Now that the inhabitants of the South Pacific are writing their own history, the artefacts in the Göttingen Cook/Forster Collection are being re-examined, and in many cases, re-understood.

The collections enrich teaching, offering students the opportunity to experience their subjects in a whole new way, as the article from Anne-Katrin Sors on the re-opening of the University Art Collection relates.

Objects that appear old today could tomorrow be the inspiration for new research, or could lead to important insights into human history. This is why the University of Göttingen is bringing its collec-



tions into the digital age. Digitised and described, catalogued and accessible from anywhere, they're forming a vital part of a new virtual research environment. The contributions from Norbert Eschbach, Nicolaas Rupke and Wolfgang Böker, as well as Gerhard Lauer and Norbert Lossau explain not only how this is being accomplished, but how important it is for future research.

I read the articles in this issue with great pleasure and I hope you find them equally interesting. This edition of our research magazine has been designed to give you a taste of a special exhibition we are currently planning. Called 'Objects of Knowledge', it will be one of the highlights of our 275th anniversary celebrations in 2012, and will open in the Paulinerkirche next June.

I hope to be able to welcome you there.

Professor Dr. Ulrike Beisiegel
President

WHY COLLECT?

*Dr. Marie Luisa Allemeyer, Dr. Dominik Collet,
Prof. Dr. Marian Füssel*

- 4 The 'Academic Museum'**
Göttingen's University Collections as a Space of Knowledge, Culture and Science



Dr. Susanne Ude-Koeller

- 12 275 Years of Collecting: Anniversary Exhibition Brings the University's Treasures Under One Roof**

*Prof. Dr. Dr. h.c. Heinrich Detering
and Dr. Wolfgang Wangerin*

- 14 Flying on the Wings of Imagination**
A One-of-a-Kind Collection Illustrates Three Centuries of Childhood



- 19 The Seifert Collection of Historical Children's Books**

INSPIRING RESEARCH

Prof. Dr. Thomas Friedl

- 20 The Little Green Wonder**
Unlocking the Secrets – and Potential – of Microalgae

- 25 The Göttingen Culture Collection of Algae**



Dr. Birgit Großkopf

- 28 What Our Ancestors Reveal**
Cutting-Edge Research on Centuries-Old Bones

- 33 The Collection of Historical Anthropology**

Dr. Gundolf Krüger

- 34 Treasures from the South Seas**
Changing Perspectives on the Cook/Forster Collection's Polynesian Artefacts

- 37 The Ethnographic Collection**

Beate Herrmann

- 41 Furthering German-Polish Reconciliation: The Łódź Documents in the Ethnographic Collection**

Dr. Mike Reich and Alexander Gehler

- 44 Giants' Bones and Unicorn Horns**
Ice Age Elephants Offer 21st Century Insights



- 51 The Geoscience Museum and its Collections**

Prof. Dr. Dr. Michael Schultz

- 52 Talking Heads**
Unearthing the Stories Behind the Skulls in Blumenbach's Collection

- 57 Secrets of the Bog Bodies**

PROMOTING LEARNING

Dr. Anne-Katrin Sors

- 58 **Pictures at an Exhibition: Collection Re-Opening Offers Unique Learning Opportunities**

- 60 The University Art Collection



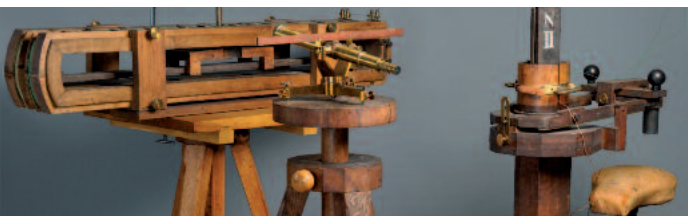
Prof. Dr. Norbert Eschbach

- 62 **The Shard Connections**
Göttingen's Place in the Ancient Greek Pottery Network

- 69 The Cast Collection of Antique Sculptures

Prof. Dr. Markus Münzenberg

- 72 **Witnesses of the Past, Teachers of the Future?**
How Early Physics Instruments Helped Us Understand the World



Previous issues of the Georgia Augusta are available online for download at www.uni-goettingen.de/wissenschaftsmagazin
 Issue 1 · **Leben braucht Vielfalt – Biodiversität** (2002)
 Issue 2 · **Gehirn und Verstehen** (2003)
 Issue 3 · **Europa – Alte und Neue Welten** (2004)
 Issue 4 · **Materialien und Stoffe** (2005)
 Issue 5 · **Kulturen und Konflikte** (2007)
 Issue 6 · **Zahlen, Formeln, ungelöste Rätsel** (2008)
 Issue 7 · **Freiraum für neues Denken** (2010)

- 79 The Collection of Historical Physics Instruments

Prof. Dr. Robert Otto Pohl

- 80 **The Value of Demonstration: Robert Wichard Pohl's Lecture Collection**

Prof. Dr. Laurent Bartholdi, Prof. Dr. Stefan Halverscheid, Prof. Dr. Russel Luke, Prof. Dr. Max Wardetzky

- 82 **The Collection of Mathematical Models and Instruments: Perspectives for Tomorrow**

DIGITISING HERITAGE

Prof. Dr. Nicolaas Rupke and Wolfgang Böker

- 84 **The Natural World through Blumenbach's Eyes**
Digitising the Legacy of Göttingen's Greatest Collector

Dr. Jochen Heinrichs

- 92 **New Life for Old Plants**
The Importance of Biomolecular Research on Botanical Collections

- 95 The University Herbarium

Prof. Dr. Gerhard Lauer and Prof. Dr. Norbert Lossau

- 98 **Giving Collections a Global Voice**
How Digital Archives are Revolutionising Research

- 101 The Herzog August Bibliothek in Wolfenbüttel



- 103 The Göttingen Centre for Digital Humanities

- 106 List of Collections

- 110 List of Authors, List of Institutions

The 'Academic Museum'

Göttingen's University Collections as a Space of Knowledge, Culture and Science

Marie Luisa Allemeyer, Dominik Collet, Marian Füssel

As one of the key locations of German enlightenment, the University of Göttingen hosts a wealth of collections ranging from natural history to anthropology, and from technology to corporate-academic heritage. These collections mark the establishment of new spaces of knowledge and institutional settings that have come to characterise the modern research university since its foundation in the 18th century. Scientific objects continue to delineate the various emerging academic disciplines, allowing academics to use material culture in order to mark their professional identities. The Göttingen collections illustrate historical concepts of objectivity, cultures of evidence or the performance of knowledge. However, contemporary exhibition techniques, focusing on visually appealing 'masterpieces', obscure rather than elucidate the crucial role academic collections played for the history of knowledge.



The 'Academic Museum' constitutes a crucial locale for a new history of science. As a space of academic self-fashioning and self-affirmation, it can illustrate historical concepts of objectivity, cultures of evidence or the performance of knowledge. University collections delineate emerging academic disciplines and allow scientists to use material culture in order to mark out their professional identities. Accordingly, their physical objects can be investigated as accumulated cultural capital for academics and their scientific fields.

Göttingen, a key location of the German Enlightenment, is an important place for research into the genesis of the Academic Museum.

With 27 collections still in existence, it is also a promising location for modern museological debate.

We will briefly sketch the history of the Göttingen collections and elaborate on the social place these collections occupied in the context of the university and the wider history of knowledge. We will also provide some thoughts on the way they are presented today and what they might look like in the future.

The University of Göttingen was founded in 1737 by the British King George II, who was also the Elector of Hanover at the time. From the very beginning, it was planned as an institution to reform academic learning and quickly grew into Germany's leading Enlightenment university. The status of theology, therefore, was significantly reduced, while a substantial number of other disciplines were included in the curriculum – often for the first time in European academic history. Indeed, many academic fields we know today were first conceived and taught as university subjects in Göttingen, among them anthropology, archaeology, art history, veterinary medicine and German philology. Many were developed in connection with and even inspired by the University's collections.

From the very beginning collections assembled for the purposes of teaching and research constituted an integral part of the University's mission. The first such collection was the library, which in a pragmatic move typical for Göttingen, later expanded into a former church. While other universities often kept their books separated along faculty lines or even individual departments, Göttingen focused on a central library, collecting books on all subjects and following a detailed classification system that was quickly adopted by many European libraries. Like in Paris, London or

Vienna, the library's holdings included not just books, but coins, paintings and natural history specimens as well.

Alongside the library, individual professors started their own teaching collections – frequently because they hoped that such visualised instruction would attract a larger group of paying students to their lectures. In 1773 several of these collections were united in the 'Academic Museum', administered by the library and situated next to the library building. The establishment of such a museum had long been called for. As in many other cases, its eventual realisation was the work of two dedicated individuals, the library's director Christian Gottlob Heyne (1729–1812) and his assistant, Johann Friedrich Blumenbach (1752–1840). While Heyne managed to persuade the university's chancellor and patron, the British King George III, to provide the initial funding, Blumenbach instigated the rapid expansion of its objects and reputation.

The museum's goals were twofold. While prominent advocates of Enlightenment ideas stressed its utility for teaching and research, it was also hoped to attract well-off students, often of noble status, and – as documented by an intense advertising campaign in contemporary journals – to raise the University's profile internationally. Many exhibits illustrate this double entendre. The prominent 'severed heads' of several Turkish soldiers, for example, appealed to ordinary visitors as spoils of war and a well-established visualisation of European supremacy. At the same time, they figured strongly in Blumenbach's studies of physical anthropology – propagating the fundamental equality of human kind.

Several important contributions quickly swelled the numbers of the approximately 15,000 original items. While the museum collected across all fields of scientific



enquiry, the most remarkable additions were ethnographical objects. In 1781 the British King financed the acquisition of objects collected during the voyages of James Cook – the largest such collection still in existence today. At the same time, Baron Georg Thomas von Asch (1729–1807), a high-ranking official in the Russian administration and an early alumnus of Göttingen University, donated several hundred boxes with material from Siberia – again a collection of exceptional quality that is unique outside of Russia. These contributions constituted the catalyst for the conception of cultural anthropology or *Völk-erkunde* as a separate academic science that was pioneered in Göttingen in the 1790s. In a similar development, the acquisition of the enormous estate of the art collector Friedrich Armand von Uffenbach (1687–1769) contributed significantly to the establishment of art history as a separate subject at the University with its own chair. Other collections developed alongside new academic disciplines, such as the collections of oriental manuscripts,

‘economic plants’, antique casts or the assemblage of human skulls, which led the Museum’s curator Johann Friedrich Blumenbach to the idea of human ‘races’ and the conception of physical anthropology.

All exhibits, however, remained united in the Academic Museum until 1840. During French occupation of the city in the Napoleonic era, the excellent links of Göttingen’s scholars to the Paris academies had succeeded in securing the integrity of the collections. Only at the death of the museum’s long-lived curator Blumenbach did the physical separation begin. Large parts of the collection left the museum and moved to the newly-founded institutes of the academic fields they had helped to create. Later collections, such as the Museums of Zoology, Chemistry or Obstetrics, were situated right alongside the teaching facilities – not least because they proved very useful in establishing and visualising the disciplinary boundaries of new academic fields.

Today Göttingen University is home to 27 collections (see appen-

dix). Many of them are now organised and institutionalised as museums, though often with limited public access and relatively small numbers of visitors. Others, such as the skull collection, are preserved out of view in their departments. A large number, such as the antique casts and of course the library, remain in active use as research tools and teaching collections, while quietly securing the independence of smaller departments in times of rapid changes in the University’s organisation.

The Academic Museum’s Place in University History

Academic collections are of crucial importance to the University as an institution and place of knowledge. First of all, the generous holdings of the University helped to establish its image as a key Enlightenment location. In the Holy German Empire, with its numerous universities locked in intense competition, illustrious academic collections could serve as a form of distinction, a fact well-documented in contemporary public perception.

The rapid expansion of the young University’s collections can be glimpsed from an account by Hinrich Wilhelm Schmeelke in 1798, in which he reflects on his education in Göttingen during the 1770s: “During my studies [the Academic Museum] had not yet made a name for itself. Now it is one of the principal collections of natural and artificial bodies in Germany. All that belongs to the history of humankind is very comprehensive [...]. You can find rarities from all three realms of nature, but one needs an expert to make a visit useful – the assistant of the Hofrat Heyne showed us all the things and Meiners assured us, that he does so just as well as the museum’s director Blumenbach. In-

The University’s Zoological Museum houses more than 100,000 prepared animals in jars, boxes and cabinets. Many of them are valuable treasures, evidence of newly discovered species, rare or by now extinct species that were collected in the 18th, 19th and 20th centuries from many parts of the world.





View from the Goethe-Allee into Papendiek in the early 19th century. The long building in the centre of the frame is the Academic Museum, then under the direction of Johann Friedrich Blumenbach.

deed Meiners remarked that he even tells the same jokes that Blumenbach was known to make.”

How the Göttingen collections presented themselves to foreign visitors by the end of the eighteenth century is illustrated by the autobiography of the Hungarian student Sámuel Fogarasi, who visited Göttingen in 1796/97. He remarks about the sights of interest: “Worth seeing in this city are the town hall, the university building, the anatomy theatre with its specimens, that is the human body parts kept in alcohol, the house of accouchement, the botanic and the economic garden, the hippodrome, the famous library with its 140,000 volumes, the Museum, the academic collection of coins, jewellery, paintings and drawings, the chamber with models and machines, the collection of monuments and paintings in the Historical Institute and the chemical laboratory.”

Ludwig Wallis’ handbook for students, published in the year

1813, mentions further “public institutions” of the university: the “Society of Sciences” and the “Gelehrten Anzeigen”, an eminent review journal from Göttingen. The handbook also provides us with information about the accessibility and presentation of the collections. On the Museum it says: “Whoever hears the name Blumenbach, and knows that this museum is under his guidance, will justifiably hold no small expectations – and he will not be mistaken! The high degree of benefit to the public provided by this marvellous collection of oddities from all realms of nature is to be admired. It can be visited on every hour with a guide for a small sign of gratitude (of two gulden; but for which up to six persons can enjoy the pleasure), it is, of course, of far more interest if you can listen to Blumenbach’s own views and remarks at the same time. This intellectual pleasure is given to his regular students of natural history. The same building also houses the

picture gallery, the coin cabinet and the chamber of models.”

About the study of anatomy he reported: “The present collection of specimens is well worth mentioning: but from a Langenbeck you can indeed expect the very best! The visit is open to every student, while the special collection mentioned can only be seen by prior arrangement with one of the professors.”

It is apparent that the collections were open to a paying audience as well as to students. A surviving book of visitors indicates a strong showing from the members of the local garrison. It appears that from the very beginning the collections had taken on the character of a ‘public’ institution in addition to their scientific purposes.

Letters and travelogues from the time around 1800 make it quite clear that Johann Friedrich Blumenbach and his collections had become a major attraction of the university. The Swiss student Gottlieb von Greyerz notes in

1799: “In his [Blumenbach’s] courses on natural history there are at least 80 to 90 students. During the lecture it is as silent as in a church, as everyone is trying to catch what he has to say, afraid of missing a single word [...]. No student will leave Göttingen without having read natural history with him, his course has indeed become a veritable fashion. [...] Next to the library is the museum, that I have so far only seen once very briefly, but which I will visit several times more with Blumenbach and his whole course. It displays many objects from the south-seas and from the north, artefacts, works from Othaiti, baskets, bags, and cords made from coco-strings, dresses of war and grief, weapons, a multitude of angling hooks of the wild nations, so well made, that they rightly put the Europeans to shame. A great many idols, displaying hideous contortions of the body, very repugnant and distasteful. Many amphibians, a mass of human embryos, of negroes etc.”

Most collections were closely associated with individual professors, who were also appointed as their director. Without the guidance of a scholar, the

objects remained silent. Intellectual conversation and sociability were crucial for the collections’ attraction. In the era of an enlightened culture of sociability, museums doubled as salons, mediating personal contacts and initiating entertaining exchanges. Consequently, when Johann Wolfgang von Goethe stayed in Göttingen in 1801, he reported on his visit to the observatory with the words: “Also Professor Seyffer showed me the instruments of the observatory with complaisance in a most copious way. I made the acquaintance of many eminent foreigners at this place, whom you always meet at highly frequented universities, and with every day the richness of my knowledge grew above all expectations.”

Indeed sociability had become so prominent, that in 1779 Göttingen’s famous physicist Georg Christoph Lichtenberg (1742–1799) felt it necessary to praise the scientific character of “academic cabinets” whose “whole destination is not for splendour but for the utility, for research and instruction. [...] Göttingen is the first university in Germany, maybe in Europe, which is provided with such a genuinely academic museum.” Lichtenberg aimed to distinguish the academic collections established for instruction through the object from the cabinets of curiosities designed – in his view – for mere pomp and idle representation.

That the collections were seen as enriching teaching practice can be glimpsed from the following announcement of an extensive lecture going on for some hours, given by Professor Hermann Ludwig Heeren in 1803: “A general ethnography of countries and populations or a critical and systematic epitome of our cur-

rent knowledge of the earth and the people living on it will be given by Sr. Prof. Heeren at 6 a.m. and will be explained by a rich stock of the best and newest maps, which he will present to his listeners, and the ethnographic collection inside the royal museum will serve to illustrate the clothing, weaponry and gear of the most distant populations.”

In addition to their representative uses, collections thus contributed to the development of the modern research university and new methods of teaching. Against the background of the traditional division of universities into four classical faculties, the collections served as a catalyst to the process of disciplinary differentiation. The art collection inspired the creation of the first chair in art history in German university history. The garden of ‘economic plants’ helped to secure the emancipation of forestry from biology. The Academic Museum, with its objects defying established disciplinary limits, inspired Blumenbach – a doctor of medicine by training and from 1776 ‘Professore medicinae extraordinario’ – to engage first with natural history and then with ethnography. After he expanded the Academic Museum into one of Germany’s leading ethnographic and anthropological collections, it paved the way for the establishment of these subjects as academic disciplines too.

The University offered a broad range of fields and items that could be collected. Its museums did not depend on a single patron or curator, and could count on support from former students and the network of the European *Respublica literaria*. It appears that the driving factor behind their rapid expansion and enormous diversity was the crucial part they played in staking out disciplinary claims during the emergence of the modern research university around 1800. As agents of scientific dissociation and delimitation they con-

One of the Ethnographic Collection’s holdings, a dancing mask (initiation costume) of the Yaka people in the Province of Congo, Angola, acquired in 1939. Photo: Harry Haase



stitute an extraordinary resource for interdisciplinary research in university history as well as the history of science today.

Göttingen's University Collections Today

The many individual collections in existence today are divided not just physically but also administratively. Most are supported by the faculties and stored in their respective buildings.

For a long time, only the botanical gardens (the 'Old Botanical Garden', the 'Experimental Botanical Garden' and the 'Forest Botanical Garden and Arboretum') and the Geoscience Museum were regularly accessible to the public. This changed in 2005, when a new campaign – the so-called *Sonntagsspaziergänge* (Sunday Walks) – was launched in order to broaden public access to collections and improve the visibility of their hidden treasures. These Sunday Walks span four academic collections that are now open to public every Sunday morning. Since then the collections of the Archaeological Institute (including one of Germany's oldest and most extensive collections of plaster casts of original antique sculptures), the University's Art Collection (with 280 paintings, 2,500 drawings, 14,000 prints, and 30 sculptures), the Ethnographic Collection (including the renowned Cook/Forster Collection) and the Zoological Museum show a selection of their contents to the interested visitor.

Although the limited opening hours and restrictions on presentational styles and scope still confine their potential, open access to these four collections is a huge step forward, particularly in comparison with the many collections which remain closed to the wider public.

Accessibility, however, is not the only issue that has to be addressed regarding the collections of the University. After all, historically most of these collections

have been open only to a very limited selection of academics. It is the perception and appreciation of these collections in the context of the modern university that poses a major challenge. At the time of their foundation, the collections embodied an investment in competitive scientific research. However, campaigns such as the Sunday Walks focus exclusively on the value these collections have today. They showcase a limited sample of 'masterpieces' separated from their historical context and singled out because of their high visual appeal, their connection with famous scientists or their marketing value – an approach that is often the result of the lack of funding and resources. Most university collections require laborious commentary and contextualisation to become accessible to and understandable for a wider public. The selected opening of some appealing collections at the expense of other, more difficult ones, however, misses the potential of these dense assemblages of knowledge.

Future Prospects

Now, almost 10 years after the Sunday Walks were launched, a lot has changed regarding the appraisal of the collections. It has become common understanding that their value is tied less to the age of the objects, their uses for publicity or their potential for teaching, but to their ability to mirror the emergence of a 'knowledge society'. Instead of displaying objects as aesthetically charged 'masterpieces', aloof from their historical contexts, they are increasingly regarded as crucial resources for the University's – and a general – history of knowledge. Their pivotal role in the ongoing processes of generating knowledge, marking distinct professional identities and acting as embodiments of scientific normativity has turned into a major source of interest. Accordingly, the focus has now shifted from the individ-

A young researcher examines a painting in the University's Art Collection.
Photo: Peter Heller

ual, visually attractive object to the relation that connected and connects these exhibits to the genesis of academic delineations and the circulation of knowledge. As a result, the University of Göttingen has initiated the development of an overall strategy on the future treatment of the collections, following a recently published recommendation on scientific collections as research infrastructures by the German Council of Science and Humanities. This strategy aims at securing and preserving the University's collections, facilitating their use for research and

teaching while raising public awareness about the collections' value. To this end, the University will install a Central Custodian's Unit that will foster and coordinate activities in collection management, research and outreach. In order to give this new approach a physical space, the University is committed to setting up a forum-like centre and exhibition space, to be run in cooperation with the City of Göttingen and its Historical Museum. This house will close the gap left by the Academic Museum. It is expected to set a new reference point for the University

and the city of Göttingen. Its goal is to promote the University's outstanding tradition embodied in its unique collections and to investigate the relation between object and science in different cultures of knowledge. This space will serve as a hub of the University's collections, museums and botanical gardens, encouraging people to visit them in situ. As a forum for encounter, exchange and education, it will explore and explain the workings of a modern university and the way it has shaped our knowledge in the past and still continues to do. ◀



Dr. Marie Luisa Allemeyer, born in 1971, studied hispanic studies, modern history and European ethnology at the Universities of Granada (Spain) and Göttingen. In 2005 she received her Ph.D. in the Faculty of Philosophy at the University of Kiel. From 2004-2008 she worked at the Max Planck Institute for History and the Max Planck Institute for Study of Multireligious and Multiethnic Societies, first as researcher on a project entitled, 'Multireligiosity in a united Europe' and then for three years as coordinator of the 'International Max Planck Research School for the History and Transformation of Cultural and Political Values in Medieval and Modern Europe.' Since 2008 she has been managing director of Göttingen University's Graduate School of Humanities, and is active as the editor and author of numerous scientific publications.



Dr. Dominik Collet, born in 1972, studied history and museology in Norwich (UK), Göttingen, and Madrid. He then joined the Max Planck Institute for History and held temporary fellowships at the Warburg Institute London, the Forschungszentrum Gotha, and the ZIF Bielefeld. In 2006 Hamburg University awarded him a Ph.D. for his dissertation on early museums as sites of cross-cultural encounter. Since his return to Göttingen he has coordinated the DFG Research Training Group 'Interdisciplinary Environmental History' and is working on his second book, a history of the Great European Famine of 1771. His research interests include the history of museums, the cultural history of knowledge, and comparative environmental history.



Prof. Dr. Marian Füssel, born in 1973, studied early-modern and modern history, philosophy and sociology at the University of Münster. In 2004 he was awarded his Ph.D. there on the topic of scholarly culture at universities in the early modern period. From 2004-2008 he held an assistant position in the History Department of the University of Münster, followed by junior professorships at the Universities of Giessen and Göttingen. Since 2010 he has been full professor for early modern history at Göttingen University, with research interests spanning the social and cultural history of universities, the history of science, military history and history theory.

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An earlier draft of this article has been published as 'The "Academic Museum" – Göttingen's University Collection as a space of knowledge production and cultural heritage', in: Opuscula Musealia 18 (2010), pp. 15-22.



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

2 June to 7 October 2012

**AN EXHIBITION TO CELEBRATE
THE 275TH ANNIVERSARY
OF THE UNIVERSITY IN 2012.**

The exhibition and extensive accompanying programme are aimed at the general public. A richly-illustrated companion volume »Dinge des Wissens« is being published by Göttingen's Wallstein Verlag.

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OBJECTS OF KNOWLEDGE

The Collections,
Museums and Gardens
of the University of Göttingen

Vizeheliotrop, invented by Carl Friedrich Gauß for his land survey campaign (depicted on 10 DM note). Sextant Troughton, London, 1810, modified by Gauß to redirect (»trop«) the sun light (»Heli«) (<http://www.uni-goettingen.de/de/historische-sammlung/47114.html>).
Photo: Martin Lüttich, Christian Leutenantsmeyer

**275
JAHRE**



Photo: Frank Stefan Kimmel

275 Years of Collecting

Anniversary Exhibition Brings the University's Treasures Under One Roof

Susanne Ude-Koeller

The University of Göttingen's valuable collections, museums and botanical gardens today count not only among the biggest and most important of their kind – even internationally – but also among the oldest. Many were created in the early years of the University, which was founded in 1737 and quickly became one of the key universities of the German Enlightenment. The collections were designed for teaching and research and were always seen as a component of the young University's scientific concept. They were never intended to be simple curiosities but rather organised academic collections curated by renowned scientists that acted as a unique selling point to help the University attract the best minds.

The collections were first housed in the University's library and then in the 'Academic Museum', which was founded in 1773 and was the first university museum in German-speaking Europe. The museum's collection was open to both academics and non-academics. Many travellers took Sunday walks through the museum to gain a better view of the world – compared to simple collections of curiosities, the Academic Museum classified items and presented them systematically under the rubrics of the natural history of humankind, animals, plants and minerals as well as technical and artistic human achievements.

As the collections expanded, they quickly ran out of room. The University responded by moving the Academic Museum to the Richtersche Haus next to the University chapel in 1793 where it was exhibited "simply but in a respectable, enjoyable way". During the 19th century, the collections were increasingly separated as part of the University's specialisation into specific subjects. Individual collections – or just portions – were given to their respective faculties or disciplines, which limited and sometimes eliminated public access.

Returning the collections to the public light and consciousness has been a key task for curators and others responsible. The University's 275th anniversary offers a special opportunity for the collections – a special opportunity recognised and supported

by Lower Saxony's Ministry of Science and Culture since April 2011.

The anniversary exhibition workgroup includes representatives from all faculty collections. It developed a concept for the first-ever exhibition of objects from all 27 university collections. The exhibition 'Dinge des Wissens' ('Objects of Knowledge') will open in the Paulinerkirche on the 2nd of June 2012. It will include a look back at the zeitgeist of the era in which the Academic Museum was founded as well as offer an overview of the collections. The collections will then no longer be divided into their respective scientific and humanities faculties as they have been since the 19th century. Instead, the objects will be arranged according to broader topics, highlighting their roles in the creation and transfer of knowledge, thus generating a more attractive exhibition for visitors. What has been collected and why? Who were the famous and not-so-famous collectors, buyers, supporters and patrons, and by what means did they gather the objects for the respective collections?

Many scientists collected objects to provide visual proof of their findings and give material form to their knowledge. But what happens when investigative techniques and knowledge change? The exhibition demonstrates in an impressive way that old objects can yield new questions and research topics.

The exhibition illustrates the historical value of the collections, shows why they still play a central role in research and teaching and offers a visual concept of their potential future use. It also links the history of the collections with the history of the city of Göttingen.

The exhibition and related activities are geared towards both the University and the general public. The planned activities include national and international symposia, talks and cultural events as well as educational and hands-on opportunities for schoolchildren. Göttingen's Wallstein Verlag is publishing the richly illustrated companion volume 'Dinge des Wissens', which will include essays on the history, theory and practice of the university collections as well as general articles on the cross-disciplinary topics of collecting. ◀



Wolfgang Wangerin (editor):
Der rote Wunderschirm. Kinderbücher der Sammlung Seifert
von der Frühaufklärung bis zum Nationalsozialismus.
With a foreword by Heinrich Detering.
Göttingen, Wallstein Verlag 2011
(440 pages with more than 400 colour illustrations)

Der Rote Wunderschirm (The Miraculous Red Umbrella) is the title of a children's book from 1898. The children in the book, who float magically through the air and discover the new and unknown in a playful, innocent way, are not unlike the children reading the book. When they read stories such as these, they also fly on the wings of their imagination to the land of fantasy, play and incomparable freedom. Creating such reading experiences is one of the most beautiful things literature does. And it brings people a joy of reading they find hard to relive as adults. Anyone who wants to find their way to the red umbrella (or almost-forgotten books from their childhood) may find what they're looking for in the Göttingen Historical Collection of Children's Books. The collection has become one of the biggest and most remarkable in the German-speaking world due to the acquisition of the Seifert Collection.

FLYING ON THE WINGS OF IMAGINATION

A One-of-a-Kind Collection Illustrates Three Centuries of Childhood

Heinrich Detering and Wolfgang Wangerin



Dr. Jürgen Seifert, a professor of political science at the University of Hanover, was not just a highly regarded legal theorist and civil rights proponent, he was also one of the foremost collectors of books for children and young adults in Germany. His collection encompasses works from the past three centuries, ranging from *Elementarwerk* by pedagogue Basedow (1774) to works from the end of the 20th century. It includes adventure stories, 'girls' books', fairy tales, popular science, nonsense poems, and textbooks. A special – and rare – focus lies on the once-widespread but now hard-to-find children's and young adult literature, penny novels, magazines, and yearbooks produced during the Weimar Republic and the National Socialist eras.

The acquisition of the collection in 2008 was a windfall not just for the Göttingen Department of German Philology. With nearly 12,000 items, the collection is one of the most comprehensive private collections of historical children's and young adult literature in Germany. It is invaluable not only for education and teaching but also

from literary, cultural, social, media, historical, and scientific perspectives. The books offer a fascinating cornucopia of new and vivid insights into the development of child-rearing and families as well as the world at large, discussing natural and technological history, the perception of past and present, the conflicts between foreign cultures and colonialism, gender roles, and even everyday life. The collection's value becomes even clearer in light of the fact that children's and young adult literature is almost never included in scientific libraries. By acquiring the Seifert Collection, Göttingen is now in the enviable position of owning an exemplary collection that is not only impressive in its breadth and composition but also completely documents the history of young people's literature of the past 250 years – as well as the history of books themselves, including the history of illustrative art.

It is often forgotten that children's books are not just comprised of text but also often contain pictures. An early example is a piece by the famous illustrator

Daniel Chodowiecki from the 18th century. His illustrations, which accompanied children's and adult literature alike, were vehicles for the popularization of Enlightenment ideals, and made a significant contribution to a common image culture. Novels, stories, dramatic pieces, almanacs, books of poetry, anthologies and (last but not least) textbooks have always been illustrated with etchings and later lithographs which were at times carefully coloured by hand. Since illustrators didn't just limit themselves to borders or frontispieces, a new connection evolved between text and pictures through the depiction of individual, recognisable text passages and scenes. Pictures are our most-

trustworthy type of non-linguistic symbolism, having the ability to continue to speak when language no longer can. The Seifert Collection offers a superb and incalculable area for research.

The scientific value of the recent acquisition is underscored by the fact that it will supplement the University of Göttingen's already extensive and outstanding collection of old and new children's books. The Göttingen State and University Library has also collected an impressive array of children's literature along with its world-famous collection of 18th

century literature – including almost all of the key children's books of the 'philanthropic' movement. The Göttingen research group for the study of historical children's books has worked on the collection since 2004 and organised three exhibitions in Göttingen and in Frankfurt's Goethehaus. The 'Library of Children's and Young Adult Literature' formed the second collection in existence and focused on modern children's and young adult literature for the Department of German Philology. In 1962, the small but valuable Vordemann Collection of historical children's books was added. The acquisition of the Seifert Collection has now improved both the quality and quan-

Andreas Gayk, *Die rote Kinderrepublik*, 1929
Pictorial book about holiday camps for workers' children organised by socialist youth organisations in late 1920s Germany.



Astrid Lindgren, *Pippi Langstrumpf*,
Illustrations by Walter Scharnweber,
First Ed. 1945
The universally-loved Pippi Longstocking lives a happy, carefree life free from adult interference.



Erich Kästner, *Die Konferenz der Tiere*,
Illustrations by Walter Trier, First Ed. 1949
A powerful anti-war manifesto disguised as a light-hearted children's fable.

Deutsche Kinderwelt,
Nr. 8, 1934
Children's magazine printed from 1926-1944, which beginning with this edition attempted to indoctrinate young readers with a strong pro-Nazi message.



tity of the already impressive collection.

An exhibition that opened October 23rd, 2011 in the historic Paulinerkirche titled 'Der rote Wunderschirm' offers a comprehensive look inside this treasure chest by displaying about 400 titles. The exhibition covers a lengthy period – from the Enlightenment through Romanticism and Realism up to the current day, representing authors of children's books from Campes to Stevenson's *Treasure Island* and Storm's *Der kleine Häwermann*, as well as works such as *Emil and the Detectives* and *Pippi Longstocking*. *Alice in Wonderland* is present along with *Struwwelpeter*; examples of abusive child-rearing techniques from the 20th century as well as National Socialist propaganda are also found. Since Jürgen Seifert was primarily motivated to collect out of scientific interest rather than as a bibliophile, he didn't just

collect 'nice, pretty' books – though plenty are among his selections, too. His primary interest was in books that disciplined and indoctrinated readers, trying to bend them to ideological goals, and completely ignoring the joy that reading usually brings to young readers. The books served socio-historical and political interests – as did the critical counter-literature. This focus is what gives his collection its unique character. The exhibition in particular dedicates considerable space to books on the subjects of war, socialism, and life in the shadow of the swastika. The comprehensive and densely-illustrated catalogue, which has been simultaneously published by Göttingen's Wallstein Verlag, offers an expanded view of the history of children's lit-

erature and uses text and pictures to illustrate genres and individual examples.

Even though only a small portion of the expansive collection is represented in the exhibition and catalogue, it is accessible in its entirety to the scientific community. Much thought has been given to the collection's organisation – considering where research and teaching should engage in a close working relationship. Thanks to the long-standing reading and teaching workshop in the Department of German Philology (founded under the amusingly archaic name *Jugendlesestube*, 'Youth Reading Parlour'), significant portions of the collection are not only available for scientific research but also for use in seminars, school projects and for individual

Heinrich Hoffmann, *Struwwelpeter*,
First Ed. 1845

Classic 19th century pedagogical picture book showing children the terrible consequences of bad behaviour, such as in this case, excessive thumb-sucking.



Theodor Storm, *Der kleine Häwermann*,
Illustrations by Else Wenz-Viëtor, First Ed. 1849
Classic bedtime story of the Little Häwermann's night-time adventures.



students. Access to the collection in library rooms that also function as work- and classrooms for students and young researchers creates new opportunities for these various usage types to benefit from each other. Due to the close proximity of its users and the manifold topics covered, the Göttingen children's book collections offer a rare opportunity for science and literature to interact and inspire each other.

The well-documented interdisciplinary research on children's and young adult literature affects not only a wide variety of fields other than cultural and literary sciences but also every age group. Danish children's author Hans Christian Andersen said he writes his stories for children whose parents are looking over their shoulders, "and so I have to offer both something". Even Andersen's modern relative Erich Kästner didn't just write children's books – he referred to this portion of his life's work emphatically as 'novels for children'. Any author that puts so much effort into placing their children's books into an adult genre has long since turned their back on the conventional educational views that had persisted since the Enlightenment. He didn't look at children as not-yet-adults but rather viewed adults as no longer children. For him, adulthood was just a continuation of childhood using different means. His compatriot Astrid Lindgren also encouraged children's authors to stay in touch with the child they once were. The Swedish educator Ellen Key built on this concept, which emerged during Romanticism and then became established as an understanding of the importance and value of childhood during the modern literary period, when she proclaimed the 'century of the child' around 1900. Modern children's literature, which followed her call, has become increasingly adult literature, written equally for children and former children.



Robert Louis Stevenson, *Treasure Island*, Illustrations by Frank Inscall, First Ed. 1883
The quintessential adventure novel, thrilling generations of children with stories of pirates and buried treasure.

"Don't let your childhood escape!" was Erich Kästner's categorical imperative.

Therefore, the collections are not just representations of historical literary documents from a distant, foreign past. They remind us intimately of the lost magic of our first books. Not only reminders of the child we once were, they give us a fresh look at the realities of our children. They also warn us – especially Seifert's unique collection – about the abuse of this magic for creativity-stifling and malevolent purposes. However, what can be best discovered in the Göttingen children's and young adult book collection – beyond all historical and social scientific aspects – is a vision of the kind of society in which we ourselves want to live. ◀



Professor Dr. Heinrich Detering, born in 1959, studied Theology, Philosophy and German and Scandinavian Studies at the universities of Heidelberg, Odense (Denmark) and Göttingen. He completed his doctorate in 1988 and his habilitation in 1993. After a one-year interim professorship in Munich, he was offered a position at the University of Kiel in 1995. In 2005 he returned to Göttingen, this time as chair of modern German literature and comparative literary science. Prof. Detering has been a fellow at the Wissenschaftskolleg in Berlin and guest professor in Irvine (USA), Aarhus (Denmark), Bergen (Norway), St. Louis (USA) and Mainz. He is a member of the Göttingen, Mainz and Danish Academies of Science, is engaged in a leadership role in the Theodor Storm and Thomas Mann societies, and has been the recipient of numerous prizes and awards. In October 2011 he was elected president of the German Academy for Language and Literature.



Dr. Wolfgang Wangerin, born in 1944, studied Theology, Pedagogy, Philosophy and German Studies in Hamburg, Tübingen and Göttingen. Since 1975 he has been a lecturer in the Department of German Philology at Göttingen University, teaching German language didactics to secondary school teachers. He was director of the Library for Children's and Young Adult Literature and leader of the historical young people's literature research group. His main areas of interest are creative literature instruction, didactic literature theory, and aesthetic education in a pan-disciplinary context. He has numerous publications to his name and has coordinated 13 exhibitions of children's literature in locations such as the State and University Library of Göttingen, and the Goethe House and German National Library in Frankfurt (Main).

The Seifert Collection of Historical Children's Books

(red) In 2008, The University of Göttingen acquired a unique private collection of historical children's books. Encompassing such treasures as Johann Bernhard Basedow's *Elementarwerk*, a nine-volume didactic picture book published in 1774, and first editions of Hans Christian Andersen's *Thumbelina* and Erich Kästner's 1949 anti-war satire *The Animals' Conference*, the collection's nearly 12,000 titles not only document the development of children's and young adult literature over the last 250 years, they offer a unique perspective on Europe's changing political and social landscapes as well as a vision of young people's place in them.

The entire collection was assembled by Dr. Jürgen Seifert (1928–2005), a well-known civil liberties activist and professor of political science at the University of Hanover. For nearly three decades he gathered selections for the collection, obtaining rare and unique editions wherever possible. He prized the artistic value and craftsmanship of the individual editions, but above all he collected with an eye to the books' politico-historical subtext. By the time of his death, the collection had grown large enough to fill 300 book cartons.

A particularly remarkable feature of the collection is the large number of hand-coloured illustrations. Representing the work of some of the most famous illustrators of the day, the pictures themselves offer a valuable piece of cultural history. As well as picture books from the 18th through 20th centuries, an important part of the collection comprises propaganda literature aimed at young people during the Nazi and Socialist eras. There are also numerous non-fiction books on nature and technol-

ogy that reveal how science was presented to children, often including the otherwise seldom-preserved exercise books that accompanied them.

With respect to its size and composition, the Seifert Collection is unique worldwide and of inestimable scientific value. It was jointly acquired for the University by Prof. Dr. Heinrich Detering and Dr. Wolfgang Wangerin with additional financial assistance provided by the Lower Saxony Foundation, the Lindemann Foundation, the Ministry for Sci-

ence and Culture, and the Monastic Chamber of Hanover. The Seifert Collection is currently set up in the Library for Children's and Young Adult Literature of the Department of German Philology, and is open to researchers as well as students and schoolchildren in the framework of projects and seminars. In addition, a public exhibition showcasing several hundred books from the collection and featuring guest lectures on various aspects of children's literature will be running in the Paulinerkirche through February 2012.

ARBEITSGRUPPE HISTORISCHE JUGENDBUCHFORSCHUNG
SEMINAR FÜR DEUTSCHE PHILOGIE DER UNIVERSITÄT GÖTTINGEN
NIEDERSÄCHSISCHE STAATS- UND UNIVERSITÄTSBIBLIOTHEK GÖTTINGEN

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The Little Green Wonder

Unlocking the Secrets – and Potential – of Microalgae

Thomas Friedl

Algae exist almost everywhere, from the open ocean to the top of high mountains, and from the hottest, driest deserts to the frozen polar ice-caps. They are also the subject of increasing scientific interest, thanks to their ability to absorb greenhouse gases and potential to function as a renewable and quick-growing source of biofuel. The Göttingen Collection of Algae Cultures is one of the world's most comprehensive databases of microalgae reference strains. In addition to supplying scientists around the world with living samples, it is actively involved in numerous research projects designed to expand our knowledge of the habitats, distribution patterns and potential applications of these remarkable organisms.



The Growing Importance of Microalgae

Algae are an enormously diverse group of organisms permanently capable of photosynthesis, and therefore of producing oxygen and storing energy in their biomass. In the oceans that cover three-fifths of the earth's surface they occur in tremendous amounts as phytoplankton in the open water and as benthic forms on rocky shores. As a climate component algae are at least as important as land vegetation, especially because of their ability to absorb the greenhouse gas CO₂. Microalgae, which also include the prokaryotic cyanobacteria, build up a large variety of valuable compounds in their cells from light energy and as a result are also of increasing economic

importance. In technical processes, microalgae even have the potential to substitute for fossil fuels (e.g. crude oil) and thus may contribute to reducing CO₂ emissions. Algae play a pivotal role in global cycles of matter due to their function as primary producers, especially in aquatic ecosystems. However soils, leaf surfaces, tree bark and rocks also provide appropriate habitats for algae, though this is still insufficiently explored. Microalgae exhibit a surprising diversity even in arid and hypersaline soils. In their terrestrial habitats microalgae are essential as they protect against erosion, act as precursors for land vegetation and provide very important services to other organisms through their ability to absorb energy, carbon and, in case of cyanobacteria, also nitrogen. Examples for terrestrial green algae are shown in Figures 1-4.

Currently the Göttingen Culture Collection of Algae (SAG) is closely linked with several research projects focusing on the biodiversity and distribution of microalgae in terrestrial habitats. Here, the SAG is of pivotal importance for the correct identification of terrestrial algae. The SAG maintains and provides a large variety of reference strains which have been deposited and reliably identified by specialists over many

years and thus serves as an invaluable database for comparisons. Because microscopic features of terrestrial algae are rather scant (Figs 1-4), the SAG culture strains themselves are usually not used for identification by comparison but rather their DNA signatures only. So far about 37% of all SAG holdings have been sequenced for the best-established molecular signatures, the nuclear-encoded 18S ribosomal RNA and plastid-encoded *rbcL* genes. Available from public DNA sequence databases, the number of reference sequences from SAG strains is constantly growing, augmented by the SAG's own sequencing efforts.

Assessing Biodiversity through DNA

Although numerous new isolates of terrestrial algae are being established in the research projects with which the SAG is involved, their focus is on the culture-independent assessment of algal biodiversity using DNA sequence comparisons. In many of the terrestrial habitats being investigated – in soil, for instance – microalgae are hardly visible. Only after keeping environmental samples in artificial nutrient media under laboratory conditions for two weeks or more does vivid algal growth start. This is due to the fact that terrestrial algae are present in their en-



Figs. 1a, b. *Apatococcus*, a very common genus of terrestrial green algae. Scale, 20 µm. Fig. 1a) *Apatococcus* sp., dominating a green biofilm on a man-made substrate, in this case a street lamp in Göttingen. Note the very thick cell walls which may help to make the cells resistant to drought. Fig. 1b) *Apatococcus* sp. in culture, reference strain SAG 2096 which was isolated from a concrete wall in Japan. Cells are forming packages through division, the cell walls are much thinner than in Fig. 1a.

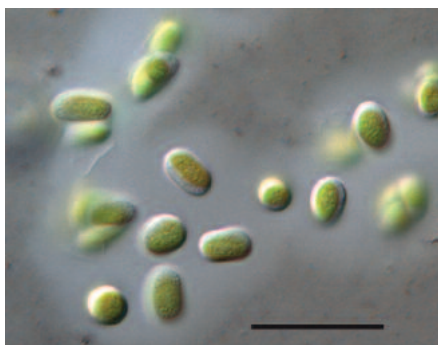


Fig. 2. A still unidentified coccoid green alga of the family *Radiococcaceae* in culture (SAG 2375, isolated from a green biofilm covering a plastic trash bin (location GOG, see text). Formation of mucilage (for adhesion and to resist drought) has been made visible by negative staining with India ink. Scale, 20 µm.

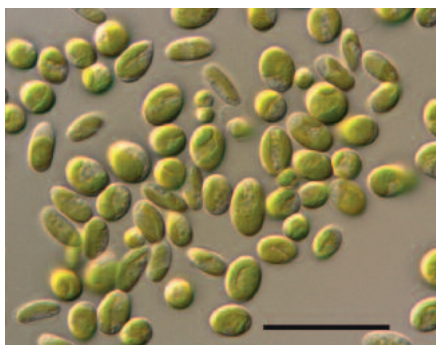


Fig. 3. *Cocomyxa avernensis* SAG 216-1, an example for a common and robust terrestrial green alga with a rather simple morphology. Scale, 20 µm.

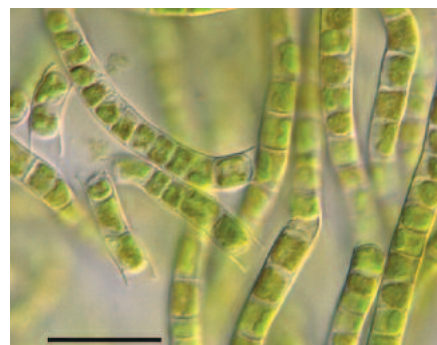


Fig. 4. *Filamentous Klebsormidium* sp. in culture (SAG K09-1_3; SAG). Reproduction is by fragmentation of the filaments (left half of the image). Scale, 20 µm.

vironments mostly as ‘resting cysts’, a non-active life stage that enables them to survive in harsh conditions such as desiccation, strong UVB-radiation, etc. However, in our research projects the assessment of terrestrial algal biodiversity is mainly achieved by DNA analyses directly from environmental samples, without culturing. Culturing would quickly become too time consuming with an ever-increasing number of samples, and additionally there is a risk of the artificial nutrient media being selective, i.e. supporting the growth of only a fraction of algae from a community while impeding the growth of others. Therefore, we only attempt isolates for selected algae with presumably interesting or novel properties. Culture strains of terrestrial algae are very promising to detect valuable compounds, which they may produce in large concentrations as part of their survival strategies. Also, we found terrestrial algae easy to stimulate for the accelerated growth required for biomass production, which means an important advantage for biotechnological applications.

The ‘Everything is Everywhere’ Hypothesis

Because terrestrial algae form resting cysts which can tolerate desiccation, freezing and high radiation, and are protected by thick cell walls (Fig. 1a) or mucilage excreted from the cells (Fig. 2), one could imagine that they are easily transported with soil particles by wind. If this is the case, the same algal species should be detectable worldwide in any habitat suitable to support the alga’s growth and no geographical distribution barriers should exist, their distribution instead being determined by ecology. This idea corresponds to a well-known hypothesis raised several years ago which basically postulates that for microorganisms, no geographical distribution barriers exist due to their small size.

In other words, where terrestrial microalgae is concerned, ‘everything is everywhere’. One of the goals in the current research projects with which the SAG Culture Collection is involved will be to

are focusing on forest and grassland at three selected areas within Germany. Here green algal communities in soil and on tree bark are being compared between 57 defined research plots which



test this hypothesis for a selection of terrestrial algae. In order to do so an unambiguous re-identification of the algal species will be required. For this and to provide comparability among the various habitats, a comparison of molecular signatures appears inevitable. We use nuclear-encoded ribosomal genes for comparisons, i.e. 18S rDNA for phylogenetic analyses and ITS-2 rDNA which provides a higher resolution than 18S rDNA as a ‘DNA barcode’ for unambiguous distinction.

Generalists and Specialists

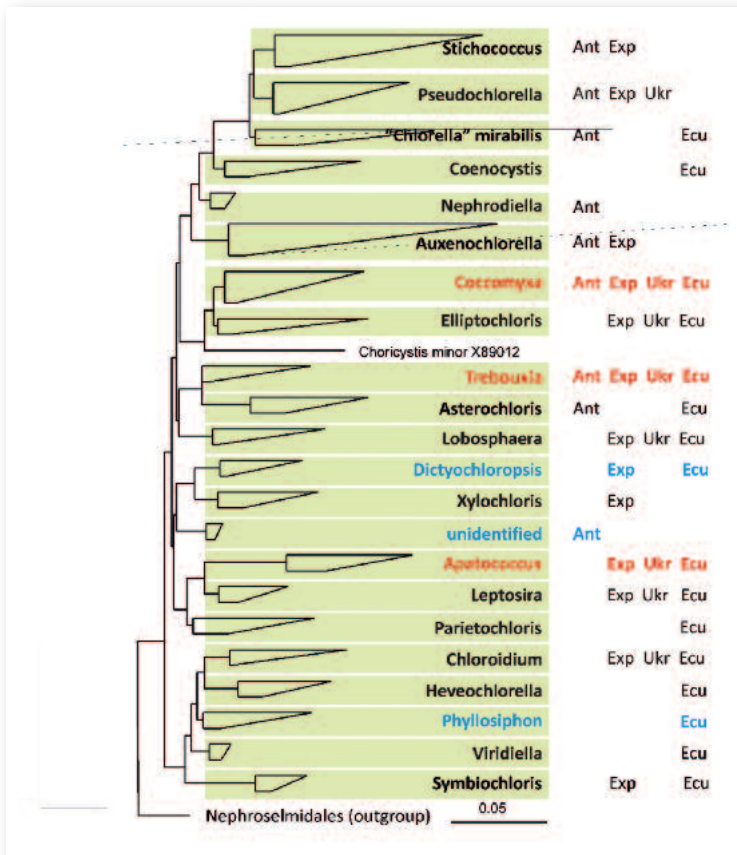
Green algae are most common in the studied terrestrial habitats and are also the most diverse group there. Currently green algae from four different localities are being compared. The German Science Foundation-funded Biodiversity Exploratories (large-scale and long-term research projects to conduct functional biodiversity research; www.biodiversity-exploratories.de)

represent different soil types and levels of intensity in land use. Another research project is focusing on tropical mountain rainforest in Ecuador’s Podocarpus National Park. Here epiphytic crusts of green algae covering tree bark, leaves and in soils are compared at defined plots at three different altitudes (1000 m, 2000 m and 3000 m). A third intriguing habitat for soil algae is the saline soils of the dry steppe vegetation in the Chernomorskiji Biosphere reserve, which is close to the Black Sea in southern Ukraine. But the most distant and harsh environment is represented by Antarctic soils, specifically the ice-free soils bordering glaciers on King George Island, Maritime Antarctica (Fig. 5).

A phylogenetic analysis using 18S rDNA sequences from members of the green algal class *Trebouxiophyceae* obtained from samples of the four terrestrial habitats were compared with corresponding sequences from refer-

Fig. 5. Ice-free soils bordering a glacier on King George Island, Maritime Antarctica, provide a suitable environment for diverse algal communities which are investigated in an ongoing project with which the SAG Culture Collection is involved. Photo: M. Olech

Fig. 6. Phylogenetic analysis of 18S rDNA sequences from members of the green algal class *Trebouxiophyceae* (based on a maximum likelihood approach, with partial sequences added using a maximum parsimony tool). Triangles represent clades corresponding to genera of green algae. Abbreviations indicate at which of the four studied localities the genus has been detected (Ant, Antarctica; Exp, Biodiversity Exploratories; Ukr, Chernomirskiji reserve in Ukraine; Ecu, Ecuador tropical mountain rainforest). The clades with genus names highlighted in color are further discussed in the text.



ence strains of the SAG culture collection. This revealed the distribution of algal genera among the four localities (Fig.6). Except for a single lineage, all lineages of *Trebouxiophyceae* could be identified at the generic level by comparisons with SAG reference strains. This means that the genera of terrestrial green algae we detected in these four habitats may be distributed over at least three continents, i.e. they found no distribution barriers, and are even able to withstand the extremely harsh conditions of Antarctica. The genera have already been known and isolated from habitats of temperate regions of central Europe, the habitats from which most algal strains maintained in the SAG Collection were isolated. But are there any genera which are restricted to certain localities or habitats? In Figure 6 about half of the clades (biological families) have been recovered from only one of the four studied localities.

This may indicate that we have not yet sufficiently sampled in the other localities as well as that there may be some specialized algae. For example, *Coenocystis*, *Parietochloris* and *Viridiella*, recovered in our study only from the Podocarpus National Park in Ecuador, are well known from temperate localities; the representatives of these genera maintained in the SAG were all isolated from central Europe. Other single findings may be explained by the specialisation of certain genera. For example, *Phyllosiphon* is known as a parasite living inside the leaf tissue of tropical plants yet was found only in crusts covering leaves in the tropical mountain rainforest. *Dictyochloropsis* is a common genus of tree bark algae and was recovered in our study from the only two habitats that contain trees, the Exploratories and the rainforest.

Our comparison also revealed clades which were present in all four studied localities. These may



Photo: Sascha Bubner

The Göttingen Culture Collection of Algae

The increasing interest in microscopic algae as 'cell factories' capable of producing valuable compounds, their potential to serve as a sustainable source of energy and thus decrease CO₂ emissions, and rapid developments in genomics have ensured that algal research is at the cutting edge of science. This requires living and reproducible cultures of microalgae, including cyanobacteria. In nature, however, microalgae are found mostly in only low densities and intermixed with other microorganisms, and therefore their isolation, purification and cultivation on defined nutrient media is required. Improving the representation of the diversity of algae in culture by establishing new isolates as well as studying their potentially valuable properties for biotechnological exploitation is still a major challenge in microalgal research and one of the main goals of the Culture Collection of Algae at the University of Göttingen (SAG).

The SAG is one of the most comprehensive resources of microalgal cultures in existence. It supports all kinds of algal research through ex situ conservation of algae and expert knowledge on identifying and isolating. Containing approximately 2400 strains (representing 538 genera and 1424 species), all major lineages

of algae and cyanobacteria are represented in the SAG's holdings. Over 450 strains are type reference strains of especially high value for algal taxonomy. As one of the largest service culture collections worldwide, the SAG receives an average of about 600 orders per year which results in an average of about 2100 cultures dispatched; both numbers are continuously increasing. The majority of users are from the international scientific and biotechnology communities. About 67% of all annual orders are made by academic institutions, with more than half of this coming from schools and universities within Germany.

The SAG also actively participates in algal research. Current research projects with which the SAG is involved include biodiversity analysis of various habitats of terrestrial algae (see main article), the isolation of biofouling microalgae and their subsequent utilization as antifouling test-organisms, as well as screening for commercial metabolites with expert input into process development and up-scaling.

The SAG was initiated when Professor E.G. Pringsheim (1881–1970), one of the pioneers in algal research, arrived in Göttingen in 1953 after living as a World War II refugee scientist in England. To-



Photo:
Sascha Bubner

day, 304 strains isolated by Prof. Pringsheim and his wife Olga are still available from the SAG.

As a modern service infrastructure, the SAG continues to serve as an ever-expanding repository of expert knowledge on identifying, isolating, culturing and ex situ conservation of algal material. This is reflected in the enormous number of publications that have taken advantage of SAG's established expertise.

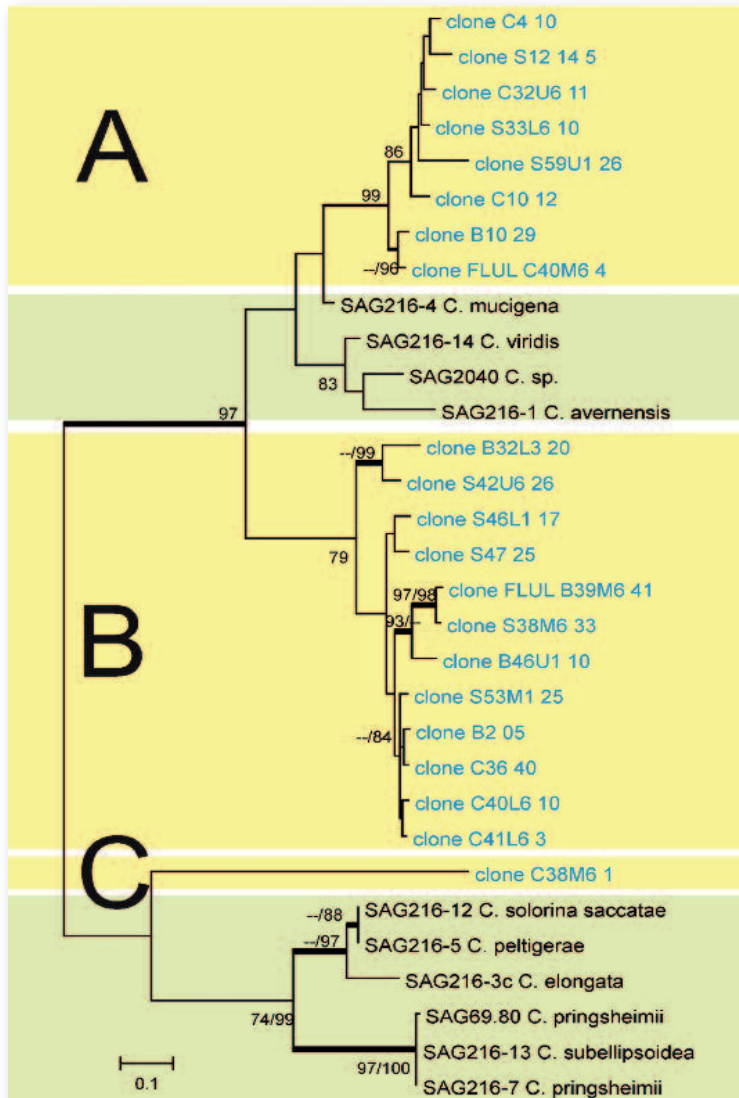
Long-term maintenance of living microalgae always carries the danger of contamination, loss or undesired genetic modifications. The SAG faces a continual challenge in circumventing these restrictions, which it tackles by both improving existing culturing methods and developing new ones such as the cryopreservation of algal cells at ultra-low temperatures. In addition to the rapidly increasing demand in algal-related services, the SAG team is working on increasing the value of its holdings, in particular through the constant expansion of the number of its algal strains and parallel efforts to further develop the curation of accompanying data.

Maike Lorenz and Thomas Friedl



Photo:
Sascha Bubner

Fig. 7. Phylogenetic analysis of the DNA barcode, ITS2 rDNA, for the genus *Coccomyxa*. The sequences that were used represent DNA clones obtained from various localities within the tropical mountain rainforest, Podocarpus Ntl. Park, Ecuador (highlighted, yellow) and formed three lineages (A,B,C) or were from reference strains of the SAG culture collection (highlighted, green).



represent particularly common algal genera. For example, *Trebouxia* is a very common lichen symbiont, and in all four studied localities lichens were common.

Determining Family Ties

There are two more examples of algal genera with a wide distribution. One is a clade of *Chlorococum*-like green algae (members of the class *Chlorophyceae*) which contains references isolated from the Arctic, i.e. strains that are maintained in a specialized 'culture collection of cryophilic organisms' (CCryo) as well as reference sequences from sources other than the SAG. It shows that

an algal 18S rDNA clone from the Ecuadorean rainforest shares an almost identical sequence with a reference strain isolated from the Arctic (*Chlamydomonas* sp. CCryo 147-0; Fig. 7) – a finding strongly supporting the 'everything is everywhere' postulate for microalgae. In addition the 18S rDNA clones from the German Exploratories and those from Antarctic soil have their next closest relatives in strains isolated from the Arctic (Fig. 7) – further evidence for the distribution of terrestrial algae being free of barriers, even from pole to pole. The other example is the clade representing the genus *Coccomyxa* (Fig. 7). This

is a minute unicellular genus of *Trebouxiophyceae* with a rather simple morphology (Fig. 3). The SAG holds authentic reference strains for almost all the previously-described species of the genus *Coccomyxa*. A more detailed phylogeny based on 18S rDNA sequences shows the algal clones recovered by our study nested among five reference sequences from the SAG Collection. However, an unambiguous identification at the species level is still not possible: several SAG reference strains represent different species, but share almost identical sequences and for other clones the next closest relatives are still unidentified. The more detailed phylogeny also revealed a novel lineage which is distinct from any SAG reference strain and which comprises clones recovered from the German Exploratories as well as the Ukrainian steppe zone. New lineages, possibly representing new taxa, may be revealed by a closer examination of the clades identified by 18S rDNA sequence comparisons and an expanded sampling within a certain genus.

To identify rDNA clones recovered from Ecuadorian mountain rainforest we are using ITS2 rDNAs as DNA barcodes of high resolution power. For the *Coccomyxa* example the ITS2 rDNA phylogeny shows the Ecuador rainforest clones distributed on three clades (Fig. 7). For those in clade A, several SAG reference strains may be closer relatives. For the clones in clades B and C no close relatives are known, and therefore they may even represent new species (Fig. 7). Another particularly interesting example for a genus of terrestrial green algae for which our research revealed worldwide distribution of a known species as well as new species from just a single locality is provided by *Apatococcus* (Figs. 1a,b). The diversity of the genus has been explored just recently by a research project that targeted green biofilms covering house

façades, roof tiles and other man-made substrates in urban environments. This project added five new reference strains, now available from the SAG, to the authentic reference strain *A. lobatus* SAG 2037 with which the taxonomic type of the genus is linked, demonstrating the extended diversity of the genus. These reference strains certainly represent more than just a single species of *A. lobatus*, but yet have not been formally named and described. A molecular survey of such biofilm algae using the ITS2 as DNA barcode recovered all known lineages within the genus just from a single locality, GOG, which is the lid of a plastic trash bin in Göttingen. Several *Podocarpus* National Park environmental rDNA clones were identical to those from the Göttingen GOG locality and the authentic reference strain *A. lobatus* SAG 2037, demonstrating the worldwide distribution of this species. However, the Ecuadorian clones formed two more lineages, one without any close relative and the other somehow distantly related to a SAG reference strain and GOG clones. The two lineages still appear locally confined to Ecuador, but it is possible that a more expanded sampling in the



Photo:
Sascha Bubner

vicinity of the GOG locality may recover both new species from Germany as well.

Conclusion

Terrestrial green algae can be well-identified by comparing 18S rDNA sequences and ITS2 DNA barcodes with the corresponding molecular signatures from reference strains of the SAG at the level of genera and species. A worldwide distribution of genera of terrestrial green algae, without barriers between continents, was clearly revealed by molecular comparisons between four geographically rather distant locali-

ties and central European strains available in the SAG Collection. However, new lineages within a genus for which no close relatives from known reference cultures exist were revealed by a closer examination of 18S rDNA clades as well as the ITS2 DNA barcode analyses in several cases. This finding may indicate the presence of specialised species which may be confined to a certain locality. However, at present it is still unclear whether these specialised species are confined to certain unique ecological niches or exhibit a restricted geographical distribution. ◀



Prof. Dr. Thomas Friedl, born in 1960, studied Biology in Munich and Marburg. In 1989 he received his PhD from Bayreuth University. He completed postdoctoral research in the USA at Duke University and Louisiana State University, and in 1997 finished his habilitation in Bayreuth. After this, he became a Heisenberg Fellow of the DFG (German Research Foundation) and was lecturer at the Technical University of Kaiserslautern. Since 1999 he has held the position of professor at the University of Göttingen where he is head of the department Experimental Phycology and Culture Collection of Algae (EPSAG) and director of the Göttingen Collection of Algae Cultures (SAG). His main scientific interest is the taxonomy and molecular phylogeny of algae and cyanobacteria, with a focus on diversity assessment of algae and cyanobacteria in terrestrial habitats.

Acknowledgements

I am indebted to my PhD students, Christine Hallman, Fabian Faßhauer and Ladislav Hodač for their enthusiasm and provision of their preliminary, still-unpublished results. The team at the SAG Culture Collection, Dr. Maïke Lorenz, Gabriele Curdt-Hollmann, Marlis Heineman, Ilse Kunkel and Hella Timmermann are thanked heartily for all their skillful work. I thank Prof. Igor Y. Kostikov, Kyiv University (Ukraine) for inviting me to the Black Sea coast in spring 2010. Prof. Maria Olech (Krakow University, Poland) and Prof. Andrzej Massalski (Kielce University, Poland) are thanked for allowing us to work with their soil samples from Antarctica. I am grateful to my wife for supporting my work with her patience and critical comments. The Deutsche Forschungsgemeinschaft is acknowledged for financial support through three research projects and the BMBF for supporting collaboration with University of Kyiv.



View of parts of the collection of primate skulls.
Photo: Frank Stefan Kimmel

What Our Ancestors Reveal

Cutting-Edge Research on Centuries-Old Bones

Birgit Großkopf

The University of Göttingen is currently planning to erect a new study centre on campus. In the course of the digging the foundation, though, the remains of a Catholic cemetery were unearthed. This cemetery had been set up in the middle of the 19th century and remained in occasional use into the early 20th century. The conditions of the approximately 60 skeletons that have been salvaged from it are varied, but there was one unexpected discovery: some of the skulls were apparently sawed open prior to burial. On one individual, all the extremities had been sawed through and the skeleton was not even in anatomical arrangement in the grave. The discovery of an individual whose entire skull was missing led to the hypothesis that the skull might possibly be found in one of the University's collections.



There is a long tradition of collections. In 1773 the first ‘Royal Academic Museum’ was founded in Göttingen, for which curator Johann Friedrich Blumenbach (1752–1840) collected numerous items from a variety of fields of ‘natural history’ to be displayed as exhibits. As a result of his dissertation *De generis humanis varietate nativa* (*On the natural varieties of the human species*) of 1775, in which he defined five ‘racial types’ on the basis of ‘morphological varieties’ of skulls, he is considered to be a father of scientific anthropology and founder of Germany’s oldest collection of skulls. Although for some years now the Johann Friedrich Blumenbach Institute for Zoology and Anthropology has been named after him, the skull collection is to be found in the Centre of Anatomy of the University of Göttingen (see article by Michael Schultz, this volume).

There is another collection in the department for Historical Anthropology and Human Ecology, however, which comprises a large number of human skull and skeleton series as well as numerous primate skulls. There are, additionally, several mummies, one of which was from Blumenbach’s property. The skeleton series originate from

a myriad of periods, regions and populations and are in varying conditions, making it possible to carry out research on a wide variety of topics. For example, skeletons degrade to different degrees as they lie in the ground, which can significantly restrict scientifically-relevant analyses. The constant optimization of methodical approaches in anthropological work is, therefore, a crucial scientific task.

Numerous theses, e.g. on the extraction of ancient DNA or the optimization of analysis systems, have now made it possible with the aid of molecular genetic analyses to draw conclusions on things such as family relationships, marriage patterns, lactose intolerance, regional origin, disease contamination and the mutation of tumour genes, even in historical and pre-historical populations.

The use of skeleton material or ancient DNA as a ‘biological archive’ can also make it possible to understand the history of a mutation and the dispersal of particular genetic characteristics. Diseases, for instance, create considerable selection pressure; the global distribution of the ABO blood groups is ascribed to the increased risk of individuals with the blood group O of contracting

cholera. It is a matter of debate as to whether the medieval plague epidemics may have had a similar effect. For example, a gene mutation in a chemokine receptor (CCR5 gene) occurs in around 10% of the European population. In African and Asian populations, this variant is almost non-existent. The gene encodes a receptor protein that plays a significant role in inflammatory processes in the body. Other things can latch onto the CCR5 receptor in order to gain access to the cell, however, including human immunodeficiency viruses. Homozygous carriers of the variant with the gene mutation (CCR5-delta 32) are protected against the effects of an HIV infection, while heterozygous carriers show a significantly delayed onset of the disease AIDS.

To test the hypothesis as to whether the so-called high medieval European plague epidemics affected the spread of the mutation CCR5-delta 32, the allele frequencies of individuals from two collective groups of skeletons from the Late Middle Ages were examined. One group is from a plague mass grave in Lübeck, the other from a burial zone in the same area dating from a few decades earlier. In the case of a positive se-

Microscopic analysis of bone cuttings.
Front: Birgit Großkopf,
behind: Janine Mazanec
Photo:
Frank Stefan Kimmel



lection pressure, a comparatively low proportion of the mutated gene variant would be expected to be present in those who died of the plague. However, no significant differences in the occurrence of the gene mutation were observed, making it apparent that the medieval plague pandemics did not contribute to the spreading of the mutation.

There is currently a very interesting scientific debate on the genesis of the devastating outbreaks of plague. The high virulence, rate of spread, mortality rates and symptoms described in historical sources have long provoked controversy. Now there is disagreement as to whether the cause of the epidemics, which killed around a third of the European population, was in every case the plague pathogen *Yersinia pestis*.

In the department's work group, systems of analysis are consequently being developed in order to verify various pathogens. Currently segments of anthrax bacteria, Rickettsia and the smallpox virus are being verified simultaneously with the plague pathogen. In this way, a multitude of results can be achieved with very small amounts of sample material. The use of the lowest possible quantity of material is essential where invasive examination methods on collection materials are concerned.

One particular methodological hurdle for this type of analysis – i.e. the verification of pathogens in (pre-) historical skeleton material – still exists, however. Since the initial quantities of pathogen DNA in the deceased individual are always unknown, systems of analysis must be optimized with regard to their specificity but react flexibly regarding their sensitivity. In order to achieve this, and to facilitate its implementation on (pre-) historical material, extensive control experiments are necessary, both in advance of and parallel to the analysis that is actually intended.

Moreover, the possibilities for verification depend heavily on the level of DNA degradation in the skeleton material. This is affected by the period it has lain in the ground, changes in moisture and temperature, and microorganisms or foreign matter that have penetrated the bones. For this reason, a series of Bronze Age individuals from the Lichtenstein Cave on the edge of the Harz Mountains (near the city of Osterode) represents a skeleton series of particular scientific value in many respects. The collective group, dated at approx. 1000-700 years BC, boasts a very good preservation of the ancient DNA thanks to the consistently cool temperatures in the cave. Even though no intact skeletons were found due to the remains having been disturbed, it has so far been possible to ascribe the bones to around 65 individuals. The deposited bones belong to individuals of all age groups and both sexes. Using molecular genetics, the remains can be ascribed to multiple generations of at least three different families.

The comparison between the male and female lineages of the individuals buried in the cave even made it possible to draw conclusions about Bronze Age social structures. The low variance

of the Y-chromosomal STRs only inherited paternally pointed to patrilocal marriage patterns, in which the women enter a population from outside. This was confirmed by the heterogeneity of the hypervariable regions of the mitochondrion which is inherited along the maternal lineage.

The history of the settlement can even be traced to the present day by examining variable DNA segments. In 2007, around 200 men from the Osterode area provided a DNA sample for molecular genetic analysis. The startling result of the tests was the revelation that two of the participants demonstrated a direct lineage to one of the Bronze Age families. The genetic profiles had therefore survived in that region for at least 100 generations.

In addition, the collective group of skeletons was examined regarding lactose tolerance. In general, all adolescent mammals, including humans, lose their ability to produce the enzyme lactase. Carriers of a gene mutation can, however, digest fresh milk all their lives and are able to use it as an additional source of protein, vitamins and fat. In Europe, lactose tolerance is generally the common variant, but the geographical and temporal specifics of its emer-

Preparation of bone cuttings in the Histology Laboratory.
Left: Philipp von Grumbkow,
right: Janine Mazanec
Photo: Frank Stefan Kimmel





Partitioning a tooth root for histological and genetic analysis.

Photo:
Frank Stefan Kimmel

gence and spread are still the subject of scientific debate.

By means of the lactose tolerance marker analyzed, it was possible to prove an increase in the allele from the Bronze Age, through the Middle Ages, to the present.

Based on the frequencies, it was possible to carry out further calculations on the selection coefficient, which confirmed existing theories on the co-evolution of dairy farming and lactose tolerance and dated the origin of the gene variant to approximately 12,000 years ago. On the basis of comparative studies of the frequencies in the medieval plague victims, it is additionally possible to infer a diachronically decreasing selection pressure for the allele.

Besides the ability to draw conclusions about the living and environmental conditions of (pre-) historical populations, it is also now possible to reconstruct their hair and skin colour by means of molecular genetic analyses. These days phenotype reconstruction is highly valued in forensic research, as it aids for example in the identification of skeletonised victims of crime and in building portraits of suspects based on trace evidence. Likewise true-to-life reconstructions of historical and prehistorical people are becoming increasingly important in the framework of museum exhibitions, as can currently be seen in the reproduction of three individuals from the Lichtenstein Cave at the exhibition in Bad Grund.

These examples give insight into the potential offered by historical and prehistorical bones for modern research and questions relevant to both the present and the future. In order to be able to close chronological and geographical gaps, however, the collection needs to be supplemented further. This opportunity is presented when burial remains which are not intended for reburial are found during building work and archaeological excavations.

The skeletons from the university campus will be examined anthropologically in the Johann Friedrich Blumenbach Institute before they are reburied. Perhaps the missing skull is even to be found in the Pathological Collections which exist in the Anthropological Collection as permanent loans. The collection contains around 400 exhibits which were collected from post-mortem examinations performed at the be-

ginning of the 19th century. Once considered a significant part of medical students' education, progress in medicine has meant that the collection is no longer relevant for this purpose. Changes in diagnostic and therapeutic measures have been particularly effective, such as the use of antibiotics and the development of surgical techniques. As a result, numerous disease patterns, and consequently also the traces left by diseases on the skeleton, have permanently changed.

For the anthropologists who study historical skeletons, however, the exhibits are invaluable. With them, there are preparations of medically documented pathologies which make it possible to carry out comparative studies on the morphological, histological and molecular-biological levels.

The Collection of Historical Anthropology differs from most of the University's other collections in that the artefacts are human remains. For ethical reasons it is therefore necessary to be sensitive in presenting and displaying the exhibits. At the same time there is considerable public interest in this subject, as can be seen, for example, in the high visitor numbers at mummy exhibitions and in the interest shown in excavations. The maxim must, however, always be that human dignity is to be preserved even beyond death. ◀



Dr. Birgit Großkopf, born in 1963, studied anthropology, zoology and physical chemistry at the University of Göttingen. In 2004 she received her doctorate from the University of Leipzig for her dissertation on the subject of cremation remains as source material for the reconstruction of historical populations. She spent a year as a fellow of the Institute for Demographic Research in Rostock before accepting a lecturing post in the University of Göttingen's Institute for Zoology and Anthropology. Her main research interest revolves around the morphological and histological methods for diagnosing age and gender in skeletons and cremation remains. Since 2001 she has been on the executive committee of the Society for Anthropology (Gesellschaft für Anthropologie), where she is principally engaged with student issues.

The Collection of Historical Anthropology

The Collection of Historical Anthropology in the Department of Historical Anthropology and Human Ecology is primarily used for teaching and research purposes. In the last twenty years, 66 diploma and Master's theses and 16 doctoral theses have been written in the research group, and since the transition to the Bachelor's and Master's system, 15 Bachelor's theses have been produced and the first Master's theses are about to be completed.

The collection contains skeleton series from various time periods, several mummies (primarily South American examples on permanent loan from the Ethnological Museum in Hamburg), an extensive collection of skulls of diverse populations, a collection of pathological preparations (on permanent loan from the University of Göttingen's Pathological Institute), numerous primate skulls and several primate skeletons. There are also casts of the most important hominid findings and several plaster busts.

Unfortunately there are no personnel costs budgeted for the preparation, care and expansion of the collection, which means that necessary



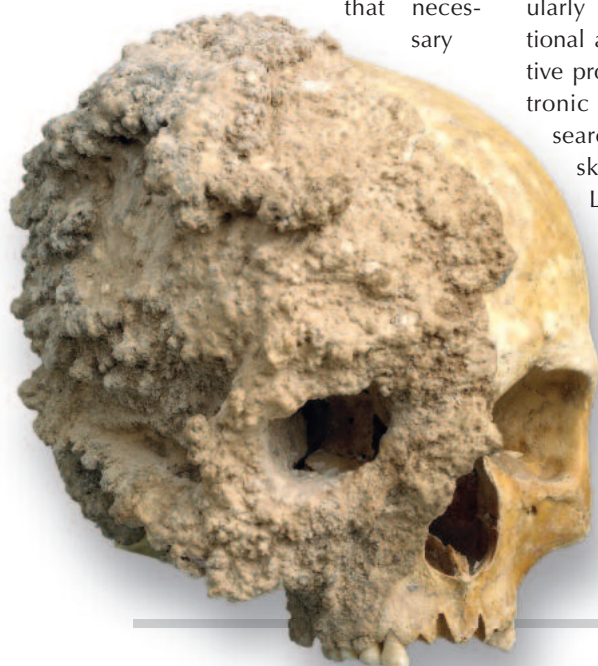
Right femur showing obvious structural changes to the bone's surface due to an infection (Osteitis). In the middle the spot at which a sample was taken for histological analysis is visible. (Pathological subcollection)
Photo: Frank Stefan Kimmel

work is only possible on a small scale. Since a variety of work is carried out on the collection's skeletons within the framework of externally-funded and thesis research, however, not only basic anthropological information but also more extensive data – including even genetic fingerprints – now exist for many of them. Histological preparations and x-ray images are also available for many of the collection's artefacts. The collection of data is constantly being expanded in order to create as extensive a biological archive as possible. A long-term goal, particularly within the context of national and international cooperative projects, is to facilitate electronic access for external researchers. In this regard the skeleton series from the Lichtenstein Cave in the Harz foothills is especially significant. The bones show extremely good DNA preservation and are being stored at -20°C in order to preserve the biomolecules. Already

now, the genetic data represents the world's first and most comprehensive genetic archive of a pre-historic population.

Care of the collection and coordination of the databases is currently being carried out by Dr. Birgit Großkopf. With the help of student assistants, work has begun on recording the initial series of the skull collection in a digital database. The data was previously recorded on hand-written index cards dating back to the beginning of the last century, which apart from the find number and a rough indication of origin contain very little reliable information. Reliable anthropological data is, however, a prerequisite for additional research on a variety of topics. Further research on the skulls' origins is also needed. Unfortunately this has been hampered by the fact that documents relating to the collection, which came to Göttingen from the Ethnological Museum in Hamburg in the 1950s, were burned during the Second World War.

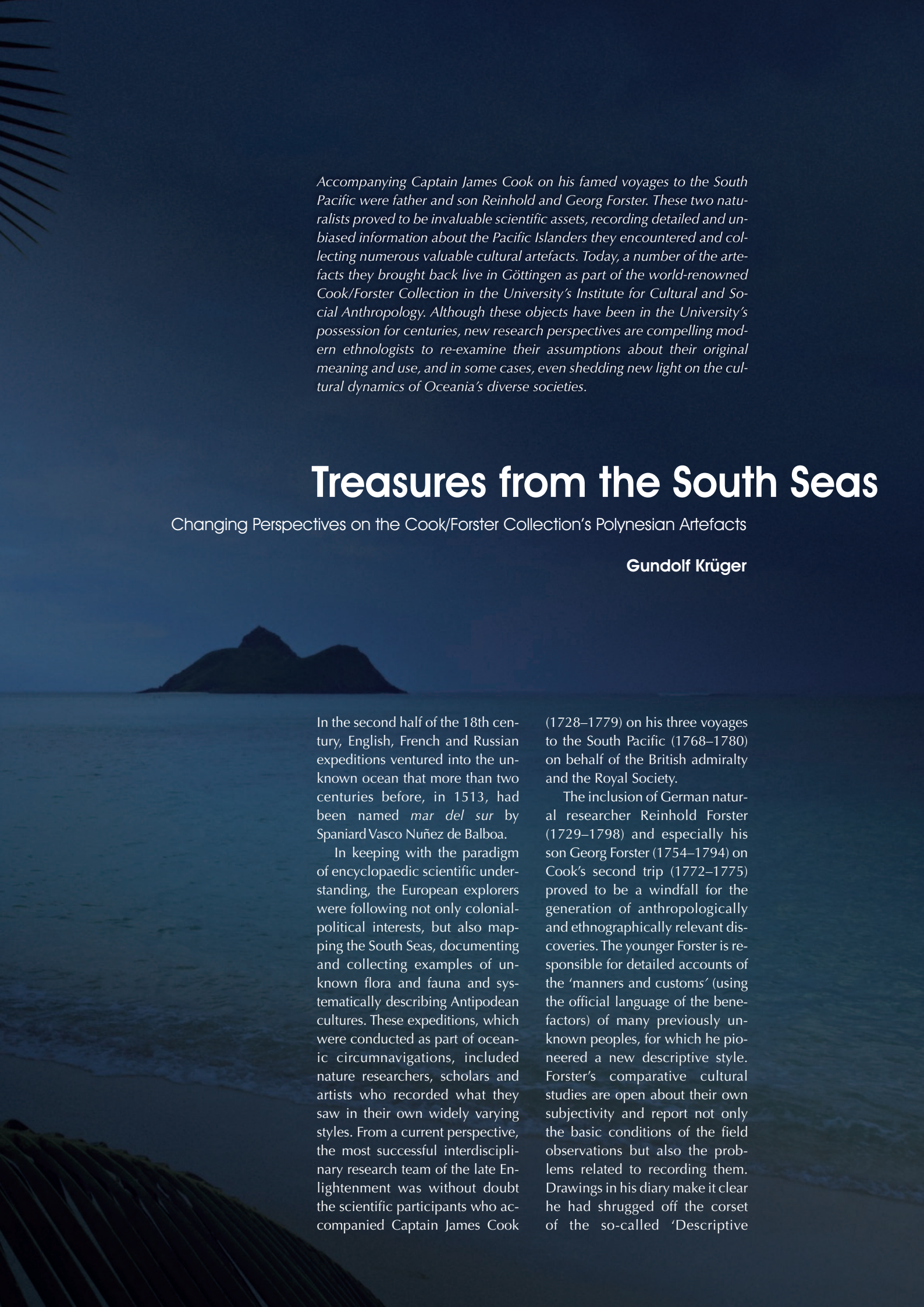
Birgit Großkopf



Bronze-Age male skull from the Lichtenstein Cave, covered in a layer of calcareous sinter. (Genetic archive subcollection)
Photo: Frank Stefan Kimmel



kii hulu manu feather
picture from Hawaii.
Representation of the
war god Kuka' ilimoku.
Cook/Forster Collection,
18th century, Oz 254.
Photo:
Frank Stefan Kimmel
Background: © tomas
del amo - Fotolia.com



Accompanying Captain James Cook on his famed voyages to the South Pacific were father and son Reinhold and Georg Forster. These two naturalists proved to be invaluable scientific assets, recording detailed and unbiased information about the Pacific Islanders they encountered and collecting numerous valuable cultural artefacts. Today, a number of the artefacts they brought back live in Göttingen as part of the world-renowned Cook/Forster Collection in the University's Institute for Cultural and Social Anthropology. Although these objects have been in the University's possession for centuries, new research perspectives are compelling modern ethnologists to re-examine their assumptions about their original meaning and use, and in some cases, even shedding new light on the cultural dynamics of Oceania's diverse societies.

Treasures from the South Seas

Changing Perspectives on the Cook/Forster Collection's Polynesian Artefacts

Gundolf Krüger

In the second half of the 18th century, English, French and Russian expeditions ventured into the unknown ocean that more than two centuries before, in 1513, had been named *mar del sur* by Spaniard Vasco Nuñez de Balboa.

In keeping with the paradigm of encyclopaedic scientific understanding, the European explorers were following not only colonial-political interests, but also mapping the South Seas, documenting and collecting examples of unknown flora and fauna and systematically describing Antipodean cultures. These expeditions, which were conducted as part of oceanic circumnavigations, included nature researchers, scholars and artists who recorded what they saw in their own widely varying styles. From a current perspective, the most successful interdisciplinary research team of the late Enlightenment was without doubt the scientific participants who accompanied Captain James Cook

(1728–1779) on his three voyages to the South Pacific (1768–1780) on behalf of the British admiralty and the Royal Society.

The inclusion of German natural researcher Reinhold Forster (1729–1798) and especially his son Georg Forster (1754–1794) on Cook's second trip (1772–1775) proved to be a windfall for the generation of anthropologically and ethnographically relevant discoveries. The younger Forster is responsible for detailed accounts of the 'manners and customs' (using the official language of the benefactors) of many previously unknown peoples, for which he pioneered a new descriptive style. Forster's comparative cultural studies are open about their own subjectivity and report not only the basic conditions of the field observations but also the problems related to recording them. Drawings in his diary make it clear he had shrugged off the corset of the so-called 'Descriptive

method' popularised by French naturalist Georges-Louis de Buffon (1707–1788), which at the time was the usual method for recording unknown *Factae* (natural objects) and *Arte Factae* (cultural objects). Material cultural artefacts were reduced to their dependence on climatic and environmental conditions and catalogued by island before being shaped into social profiles. But Georg Forster went further; in addition to natural influences, he also felt that the forms of social interaction, psychological factors and intercultural interdependencies between the groups of islanders played a role in societal conditions. On the islands he visited, he continually asked himself if cultural similarities – as well as differences – existed that could point toward common ethnic origins or cultural contact. If linguistic or cultural misunderstandings didn't cloud the interpretation of the observations, Georg Forster was often successful in recording and interpreting the encounters with South Pacific islanders in a way that took indigenous viewpoints into ac-

count. Local sources proved to be a big help with the intercultural observations of Forster, who also had a gift for languages. He befriended the Tahitian Omai, for example, who travelled with Cook back to England during his second expedition and then returned home on the third (1776–1780).

Who did Cook and the Forsters meet in the South Pacific? The descendants of peoples who had fled continental Southeast Asia and pushed into the Pacific to escape environmental disasters, wars, over-population and royal succession spats within ruling families. The current belief is that they began their sea voyages more than 4,000 years ago. They conquered the area – equal to a third of the earth's entire surface – in waves of migration that lasted into the 11th century A.D. They created societies in the South Pacific sub-regions of Melanesia, Micronesia and Polynesia that even today have maritime attributes and whose members, because of linguistic and cultural similarities, can be considered ancestors of those labelled Austronesians by

the original explorers. Although Micronesia in the northwest Pacific – so named because of its numerous small atolls – remained out of Cook's sight during his three trips, he made it all the way to the edges of Melanesia. Melanesia lies further west and more strongly reflects the tropical climes of the equator; the region's name means 'black islands' and refers to the skin colour of many of its inhabitants.

Cook and his scientific team made much more detailed observations in Polynesia, an expansive group of high, volcanic islands. The Cook expedition encountered experienced seamen that the New Zealand ethnologist Elsdon Best once labelled the most "fearless navigators" to have ever travelled the earth. German ethnologist and South Pacific expert Gerd Koch was just as impressed that these people "with a definition of life and adventure apparently so widely different from that of European thought ... were able to master the settlement of this seemingly endless area" (Koch 1984:11f).

Polynesia's typical outrigger and double-hulled boats, whose quality, speed and seaworthiness greatly impressed Cook and the Forsters, are still used today. There, local people do not see the ocean as divisive, but rather as something that binds them together – a cultural area of experience. Tongan poet and social scientist Epeli Hau'ofa labelled it "the ocean in us"; this credo was used both an identifier throughout Polynesia and as a barrier against the growing influence of Asian and Western cultures more than a decade ago. But one thing must not be forgotten: the forty-year-old global transformation process that sparked the development of a cultural identification process and the founding of a cultural and political renaissance based on maritime roots did not only unite Polynesians recently. These people have always known what we are only just now realising – that the

Fig. 2a. *Luxurious mat ta ovala* (strips of pandanus leaves), collected in Tonga, Oz 141. A nearly identical design is known on the Cook Islands. Cook/Forster Collection, 18th century, Institute for Cultural and Social Anthropology at the University of Göttingen. Photo: Harry Haase.



The Ethnographic Collection

Most German ethnological museums were founded during the colonial period around the late 19th and early 20th centuries and it wasn't until later that cultural anthropology/ethnology established itself as an academic subject at universities. However, in Göttingen, ethnological themes were addressed in research and teaching as well as in museums as early as the second half of the 18th century. Shortly after the University was founded in 1737, research focused not only on historical cultural events but also cultural comparisons based on interactions between foreign peoples. Naturalists and scholars such as Alexander von Humboldt, Johann Wolfgang von Goethe and Prince Maximilian zu Wied studied cultural items

from around the world in the 'Ethnographic Department' of the Johann Friedrich Blumenbach-run Academic Museum (1773–1840).

Cook/Forster Collection: Blumenbach's efforts brought the ethnographic collections from British captain James Cook's expeditions as well as those of his German scientific companions Johann Reinhold Forster and son Georg Forster to Göttingen. The Cook/Forster Collection includes about 500 objects from the Pacific region. As the largest collection worldwide of items collected during Cook's three South Seas expeditions (1768–1779/80), it documents pre-colonial life in the Pacific – primarily in Polynesia.

Baron von Asch Collection: The collection came from Russian doctor Baron Georg Thomas von Asch, who studied medicine in the early years of Göttingen University. Christian Gottlob Heyne, who was director of the university library at the time, intervened to bring the items to Göttingen. The approximately 180 ethnographic objects count among the earliest cultural items of primarily arctic peoples. Even before Siberia and the once-Russian Americas (today Alaska) were colonised, Asch and his collection offered what is now an authentic picture of the cultural traditions of the 'people of the far north'.

The Ethnographic Collection is the oldest academic and research collection of its kind in the German-speaking world and now spans a total of 18,000 objects and about 1,000 historical pictures and written documents. It reflects the cultural efforts and artis-



Bronze head of the Edo people from Benin/Nigeria. The sculpture was a commemorative item and portrays the face of a queen (1897).
Photo: Frank Stefan Kimmel

tic products of numerous non-European cultures. The focus lies on Africa and Asia-Pacific.

The glimpse into foreign cultures afforded by the collection's objects not only affects the past but also offers insight into today. The collection is seen as both a scientific and a practice-based teaching element of the Institute for Cultural and Social Anthropology and is used for general University studies as well as for students focusing on museum-related topics. In addition to its teaching use, the collection is also open to the public on Sundays and to internal and external international researchers.

Mask from the Tami Islands in Papua New Guinea. In the initiation ritual tago, it represents the founder of a clan or ancestral spirit (1890).
Photo: Frank Stefan Kimmel

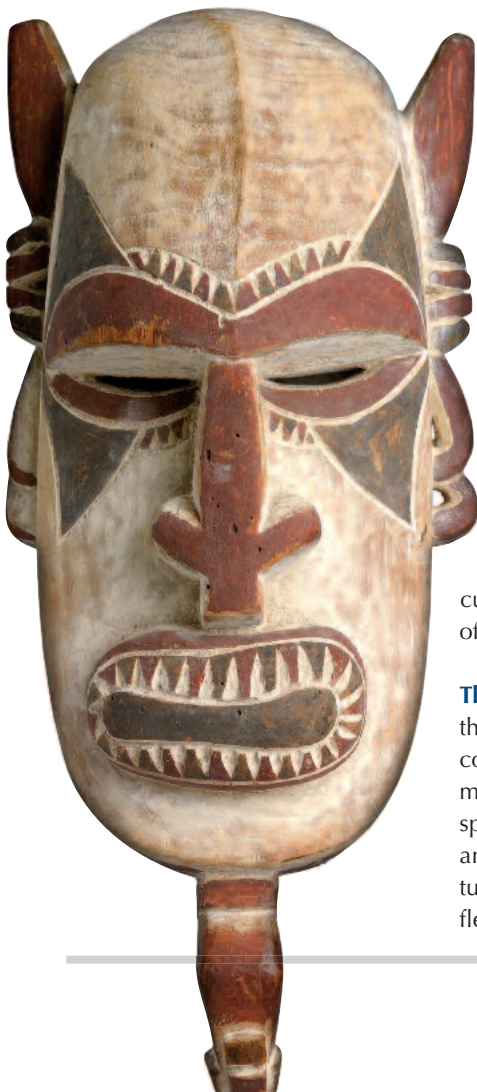




Fig. 1a. Tongan whalebone breastplate 'aofi (*tui tofua'a*) Oz 137. Cook/Forster Collection, 18th century, Institute for Cultural and Social Anthropology at the University of Göttingen. Photo: Harry Haase.

groups of islands from Hawaii and French Polynesia (Tahiti) to Samoa, Tonga and Fiji, which borders on Melanesia, had close maritime contact during pre-colonial times that weren't just based on warfare, but for centuries also provided cultural exchange. Up until the 1980s, though, German stud-

Fig. 1b. Fijian pectoral medallion *civavonovono*, crafted from whalebone and mother of pearl with typical Fijian border ornamentation. Property of the chief of Tanoa Visawaqa, about 1840. In: Hooper, Steven: Pacific Encounters. Art and divinity in Polynesia 1760-1840. London: The British Museum Press, 2006:252.



ies on Polynesia often painted a picture of a number of static, traditional cultures isolated in a gigantic ocean.

Scrapping this Euro-centric viewpoint expands our perspective on the more than 2,000 ethnographic objects that were collected during Cook's expeditions and which are now spread across more than 40 institutions and private collections around the world. Growing indications of the Polynesians' early mobility throws into question whether the location where an item was found by Europeans is actually the place where the item was produced or if it was even used there. Additionally objects that were collected during each of the three Cook expeditions – 1768–1771, 1772–1775 and 1776–1780 – could have been subject to artistic, stylistic or functional changes (see Kaepler 1998:195ff).

This once again brings up the question of the authenticity of such ethnographic items. In the '80s there was very little room for interpretation if one subscribed to the viewpoint of tribal art experts such as Adriaan Claerhout, a Belgian museum ethnologist, or William Rubin, former director of the Museum of Modern Art in New York City. Both agreed that non-European works could only be considered authentic if they strictly adhered to the cultural tradition of an ethnic group, were produced in areas controlled by members of the group and were made exclusively for their own use. This view has long since become obsolete.

As globalisation continues to spread, interaction with outsiders or foreigners has reached such a dimension that the question of authenticity in cultural anthropology had to be revisited because:

- ▶ the adoption of globally-extant objects, ideas and artistic styles can lead to local definitions for the imports and lead to original creations;

- ▶ imports can undergo semantic and symbolic transformation through adoption into foreign cultural concepts that can add to the construction of new identities (e.g. from individual to collective identities);

- ▶ adoption can be part of a creative process of changing with modern times;

- ▶ imports can lead to new, hybrid creations that constructively add to traditions and generate historic continuity;

- ▶ new, hybrid creations are increasingly the result of interactions or the stylistic influences of local cultures with each other: this raises the issue of maintaining cultural legacies and intellectual property.

Globally traded goods and cultural assets raise new research issues along the lines of those mentioned above. Similar questions, based on the years-old misjudgment of cultural dynamics in pre-colonial Polynesian societies, can be asked about the existing histories of objects in the three published documentations of the Cook/Forster Collection (1998, 2006, 2006) as well as the documentations of other collections. This is increasingly occurring, in part because more and more indigenous experts are taking a look at the local traditions and knowledge systems of their own cultures and putting special emphasis on the authenticity, origin and context of exactly those objects that serve as the oldest reflections of their cultures – known by the Maoris in New Zealand as the *taonga* (cultural treasures). This includes, without a doubt, all the cultural documents from the era of the Cook and subsequent expeditions.

Generally, material culture can no longer only be considered using only museum documentation and historical criteria from Europe's own tradition of knowledge; they must also be seen as a materialised form of social life

from an origin and context foreign to us. Their existence is increasingly seen as a means for indigenous societies to maintain their identity as they navigated historical processes. Object research should thus be more of a dialogue between local scientific concepts and foreign viewpoints. The two perspectives coupled with the real and dynamic inter-island relationships in pre-colonial Polynesia indeed result in an interesting new ethnologic evaluation for many of the approximately 500 objects, writings and photo documentations in the Göttingen Cook/Forster Collection.

One example comes from Western Polynesia and the bordering portion of Melanesia. The main settlements are the archipelagos of Fiji, Samoa and Tonga. Cook never reached the first two groups of islands but he stopped at Tonga three times. During his two stays there, Georg Forster quickly realised the importance for the entire region of this island nation and its strictly run, king-like central power. He goes into detail about the social stratification, armaments and seafaring strengths of these Polynesian societies. Due to the fact that its interaction with Europeans was primarily peaceful, Tonga had been dubbed the 'Friendly Islands'; Forster, nevertheless, challenged this by pointing out that Tongans often attacked foreign boats and were quick to wage war against their neighbours. In fact the current viewpoint recognises Tonga as a hegemonic power with a broad dominion. This idea is strongly supported by the cultural items collected there.

In October 1773, Georg Forster bought, for instance, "a large, flat chest piece that was probably made from a round bone of a whale. It was about 18 inches in diameter, as white as ivory and well polished" (Forster 1989:362). Closer inspection reveals a nearly round disk of whalebone with a

diameter of 47.5 cm. The object was made from the shoulder blade of a Sperm whale (*Physeter macrocephalus*) and has two holes for affixing a string. The 'breast shield' is part of Johann Reinhold Forster's estate. In the 'Directory of the (Forster) South Sea Items' (1799), the item is listed under 'weapons' and inventoried as 'military equipment' (Oz 137). Whereas these types of breastplates were previously seen as protective shields and discussed within the context of weaponry and warfare, it's now known that they were usually exported in rough form to Fiji and were seen as 'privileged property' (*'aofi tui tofua'a*) of Tongan royalty. They were seen by the Tongans there as a measure of value for trade. During the era of the Cook expeditions in the last third of the 18th century, these kinds of breastplates were used to buy Fijian *ndrua* boats, which were faster than the Tongan *tongiaki* boats. Images of these imported boats can even be found on illustrations from Cook's expeditions, only that the Europeans knew nothing about the trade relationships and the meaning of these bone plates within a social context. In Fiji the plates were engraved and inlaid with mother of pearl and whale teeth. There they were seen as a sign of prestige among chiefs (Figs. 1a, b). As reports from later expeditions indicate, factories eventually emerged in Fiji where migrant artisans from Tonga and Samoa worked producing jewellery from raw materials such as ivory in their own uniquely-ornamented style (see Krüger 2009: 127-140).

The Tongans always stopped off at other islands during their lengthy excursions. Samoa in particular was long regarded as a source of young brides by *ar'i'i* Tongan royalty as well as an important place for trading woven mats and skirts, which still have high social value in both

areas (Figs. 2a, b). The textile art of barkcloth weaving also reached its peak during Cook's time. It and similar materials were used for clothing and blankets and also served a ceremonial role in weddings and funerals. One piece of the Göttingen collection purchased in Tonga recently became the focus of a discussion: Hawaiian expert Wendy Arbeit believes the barkcloth *ngatu* which ended up in Cook's hands was originally brought to Tonga from far western Wallis-Futuna, a theory supported by local experts in Wallis-Futuna itself (publication in preparation). Tongan travels may have left traces even beyond Polynesia – general

Fig. 2b. Barkcloth *ngatu*, collected in Tonga, Oz 577. Potentially from Wallis-Futuna. Cook/Forster Collection, 18th century, Institute for Cultural and Social Anthropology at the University of Göttingen. Photo: Harry Haase.





Fig. 4. Tongan taunga suspension hooks made of tropical wood, Lower Saxony State Museum, Hanover, Ethnology Department, 1854, 56. Original from the Göttingen Cook/Forster Collection). Photo: Michael Tropea.

Polynesian influences have been demonstrated in ethnolinguistics and archaeology in the northern Pacific region of Micronesia. Ethnographic object research is now following suit; figurative images of god-like female forebears on the Caroline Islands are currently being studied because they are very similar to those in Tonga (Barbara Wavell, publication in preparation). Depictions of Tongan gods in collections from Cook's and subsequent expeditions analysed by New Zealand cultural anthropologist Roger Neich and his American colleague Adrienne Kaeppler are serving as the basis for the Micronesian research (Neich 2007: 213-268; Kaeppler 2008: 50ff). The standardised iconography of sculptures made from wood or whale tooth, which have been found as both standing figures and amulets as well as

hooks for hanging food, match an ancient style from Tonga. *Taunga* hooks made from whale teeth – Göttingen owns one made of wood and intended for regular use – were regarded in Tonga and Fiji as prestigious and highly valuable items (Fig. 4).

In summary it must be said that when it comes to cultural items, they are subjected to serious issues of interpretation as they travel from a foreign context into our own. We must always remember that statements about objects and related written and illustrative documentation are stuck in the structures and thought of their particular times and should not be transferred unchecked from generation to generation (see Foucault 1980: 404-410). It should be made clear that statements about ethnological artefacts continuously change because "with each new era, with each new question we ask of them, not only the view-

point but also our sight and what we see changes. And every time they give us a new answer, we interpret it against a background of changing 'perspectives and the issues of new messages'" (Hauser-Schäublin 2006:20f).

An ignorance about the lengthy interaction between indigenous cultures led researchers to often overlook the inter-cultural processes that had already taken place in the pre-colonial South Pacific. New Zealand cultural anthropologist Amiria Salmond is leading an ongoing project, in which the Ethnographic Collection is also participating, to make new discoveries about the early European encounters in this vast and fascinating region. ◀

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Dr. Gundolf Krüger, born in 1950, studied cultural and physical anthropology at the University of Göttingen, receiving his M.A. in 1979 and his PhD in 1984. From 1983-1990 he held various ethnology-related positions around Germany, including researcher at the Lower Saxony Institute for Sport History, assistant at Berlin's Ethnological Museum, lecturer at the Ethnological Institute at the Freie Universität Berlin and publicist at the Linden Museum in Stuttgart. He is currently academic director of the Ethnological Institute and since 1991 has been curator of the Ethnological Collection at the University of Göttingen. Over his career he has been involved in many research, film and exhibition projects in and on the subject of Oceania, with his main interests centring on material culture, museums and the ethnology of sport and games.

Furthering German-Polish Reconciliation The Łódź Documents in the Ethnographic Collection

I was helping with the renovations of a room in the Africa department of the Ethnographic Collection when an inventory card with the acquisition note, "Leipzig Museum of Ethnography" and "August 15, 1942" piqued my interest. The original labels on the still-packed items only heightened my curiosity. They each denoted a Polish collector, their location in a Polish museum and the year they were acquired. One example: "Zbior M. Januszewicz II partia r.1937". This immediately raised a complex question. What was the original origin of the items? Who were the collectors and what was their motivation for acquiring them?

Did the interest of Europeans affect what was offered or the form or subject of the artefacts? How did the items get to Europe and end up in Göttingen's Ethnographic Collection?

This called for classic origin research – following clues in inventories, archives, collections and literary source material in order to create an as-complete-as-possible history of their owners.

An initial look at the acquisition documents showed that it was a convoluted collection of about 300 items, primarily from Peru's Ucayali River region and north-eastern Liberia. Of artistic ethnological interest were the

Arara feathered jewellery, with colours wonderfully intact, from peoples along the Ucayali River as well as the widely varying cross-section of wooden masks and figures from the Dan in north-eastern Liberia.

I began my more detailed work with the Göttingen Łódź Collection just a year ago. Using newly discovered source material, I was able to trace the 80-year-old acquisition process of the entire Łódź Collection as well as individually reconstruct Göttingen's Łódź Collection. The collection was the subject of a restitution debate as early as 1996. The items are registered with the Magdeburg federal

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agency that coordinates the return of cultural goods and remain available to their original owners as part of Polish-German cultural negotiations. It's at this point that it became clear to me that such research into object origins is very delicate because of international cultural-political relationships. Research showed that the Łódź ethnographic collection was looted art, or *Beutekunst*, from the Second World War. When viewed in the cultural-historical context of this era, it becomes clear that the Göttingen Łódź ethnographic collection plays an important role as a symbolic witness.

But the acquisition of this collection also goes back to even earlier historic events – the second Polish republic was founded in

1918 following the end of World War I. Beginning in 1926, plans were made to establish settlements of Polish families abroad to create opportunities for new communities and trade relationships. The reason for this was unstable domestic politics. Negotiations for purchasing land were held in places such as Peru in 1927 and from 1932 to 1936 in Liberia. My research led to the family names of Polish officials and doctors who acted as collectors. Photo documentation and letters now prove for the first time the exact origin and ownership history of the collected items.

The start of the Second World War with the invasion of German troops into Poland on September 1, 1939 caused significant changes

to public life. The order for German officers to seize items from public and private institutions led to the transfer of the Łódź Collection to the Leipzig Ethnological Museum in 1940. The then-head of the Institute for Ethnology, Hans Plischke, bought a portion of the items in 1942 and had them transferred to Göttingen.

Documenting collections such as the one from Łódź not only offers a look back at the historical-cultural context, it can also make a constructive contribution to improving international relationships – in this case Germany's relationship with Poland – by offering a transparent record of ownership.

Beate Herrmann

Sash made of parrot feathers and skin, Ucayali, Peru. Purchased from the Museum for Ethnography, Leipzig, 1942.



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Giants' Bones and Unicorn Horns

Ice Age Elephants Offer 21st Century Insights

Mike Reich and Alexander Gehler

a.



Elephas primigenius das in Russland sogenannte
von Ausfließ der Lena ins Eismeer ausgegraben. Rok verzeichnet

Mammouth.



Wie es K. F. v. Raer in einem Briefe vom
27 Mai 1866 bestätigt ist das eine Copie
des von Bolkunow nach
der Natur entworfenen Zeichnung
des s.g. Adamschen Mammuthes. Bol-
kunow fand es 1804 auf und sägte
die Stoßzähne ab. Er gab in einer
Rus. technischen Zeitschrift eine
Beschreibung seines Fundes.
Seine Originalzeichnung
existirt in Petersburg
nicht mehr. - Siehe
Brandt im Bulletin
de St. Pétersb. X. 1.
Mai 1866. -
12 Juni 1866.
Kieperstein

The Georgia Augusta's collections are home to numerous original specimens and valuable findings from the early days of research into large Ice Age-era mammals such as the woolly mammoth, the woolly rhinoceros and the giant deer. Although they were unearthed and described more than 200 years ago, scholars in the natural sciences and humanities still frequently refer to them for their research.

Mammeth, mit Haut und Haar 1806 im Juras
et sic wie es vergrünelt u. verdrückt gefunden worden.

Ice Age Elephants

Today, thanks to the media, everyone knows the woolly mammoth, *Mammuthus primigenius*, as the symbol of the last ice age (Pleistocene). What is less known is that it also helped to overcome widespread disbelief regarding extinct species and therefore made a significant contribution towards the acceptance of palaeontology as a science. Belonging to the elephant family (Elephantidae), the woolly mammoth (Fig. 2), alongside the woolly rhinoceros, the giant deer and the cave bear, is one of the most well-known and striking faunal elements from the so-called Weichselian glacial period in the Early Pleistocene (Fig. 3-4).

The ancestor of the woolly mammoth is considered to be the steppe mammoth *Mammuthus trogontherii*. In the early Middle Pleistocene (around 700,000 years ago), the dental morphology of its north-east Siberian representatives had already begun to change decisively in the direction of the later *M. primigenius*. In Europe, the woolly mammoth appeared for the first time around 200,000 years ago at the time of the Saalian glacial period. In the (warmer) Eemian interglacial period

Fig. 2. Reconstruction of the woolly mammoth *Mammuthus primigenius* in the exhibition of the Royal British Columbia Museum in Victoria, Canada.



The world's first reconstruction drawing of a mummified mammoth carcass – the so-called 'Adams or Lena mammoth' – discovered by the Tungus (Evenk) Osip Šumakov in the Lena Delta in the summer of 1799 and excavated by the German-Russian botanist Johann Friedrich Adam (1780–1836) in August 1806. The drawing was made on site in 1805 by the merchant Roman Boltunov from Yakutsk and taken by Adams, along with the segmented corpse, to the *Kunstkamera* (today the Museum of Anthropology and Ethnography of the Russian Academy of Sciences) in St. Petersburg. The original drawing is no longer there. Copies created at the time were sent to Johann Friedrich Blumenbach in Göttingen and Georges Cuvier in Paris. The caption is in Blumenbach's hand: "Elephas primigenius, the so-called mammoth in Russia, excavated with skin and hair in June of 1806 at the outlet of the Lena into the Arctic Sea. Roughly drawn just as it was found, truncated and filthy". The additional notes found to the top left of the drawing are by Wilhelm Moritz Keferstein (1833–1870), Professor of Zoology at Göttingen University between 1861 and 1870. (Original in the Ethnographic Collection of the University of Göttingen)

od that followed, it withdrew again, roaming to the west once more during the late phase of this period. In the subsequent cold phase – the Weichselian glacial period – the woolly mammoth reached its maximum distribution and was native to almost the entire region of Eurasia. It also advanced across the frozen Bering Strait as far as North America, particularly into what is now Alaska and Canada [1].

The Woolly Mammoth

Mammuthus primigenius preferred open countryside and was morphologically adapted to the

tough grass and scrub vegetation of the glacial loess steppes and steppe-tundra. In size, the woolly mammoth was roughly comparable with today's elephants: large bulls reached a shoulder height of up to 3.75 metres, while female animals were considerably smaller. This means that, compared with its ancestors and relatives, it is among the smaller representatives of the mammoth lineage. Probably the most striking characteristics of the woolly mammoth were its thick hair, adapted to the climate conditions of the Ice Age, and the tusks which were extremely imposing, especially on males, curving upwards and inwards in a spiral shape [1].

With the end of the Weichselian glacial period, the days of the woolly mammoth were also numbered. It successively disappeared, first from western and central Europe, western Siberia and the Ural region, and eventually also in north-eastern Europe and in north and north-eastern Siberia. Isolated 'dwarfed' populations survived on islands in the Arctic Ocean (Wrangel Island) and the Bering Sea (Saint Paul Island) into the middle or even late Holocene until just under 4,000 years ago [3].

The changes in landscape vegetation resulting from the warmer Holocene climate are considered to be the main cause of the ex-

inction of the woolly mammoth. The human aspect, especially the hunting of this large mammal, continues to be a subject of controversial debate [2].

Of Myths and Folkloric Traditions

What remained of the ice-age giants and their ancestors was a large number of relics of fossil elephants in Pleistocene sediments, and very early on these laid the foundation for myths and legends in the local populations. The finding of large bones and molar teeth led people to believe in the existence of giants and other mythical creatures, and tusks were often thought to be unicorn horns.

In northern Asia, mammoth carcasses found in the permafrost, some of them completely preserved, gave rise to the assumption that there were giant animals living underground. In medieval and early modern Europe, the remains of the woolly mammoth and its relatives were displayed in many churches, town halls and other public buildings as alleged giants' or dragons' bones. In the 16th and 17th centuries, belief in the unicorn was also very widespread along with the belief that fossils were inorganic natural anomalies. From the late 16th century, however, the voices of scholars were increasingly heard who linked the supposed 'giants' bones' and similar objects to skeletal elements of elephants, which were already known to some degree in Europe by that time (e.g. J. G. Becanus 1569, J. Riolan 1613, W. E. Tentzel 1696) [1].

With the first published anatomical descriptions of modern elephants at the end of the 17th and beginning of the 18th century, the correct identification of fossil elephant remains was accelerated. Scholars now only disputed the question as to how the bones and teeth had come to Europe. In those days, it was very popular to believe that they were the relics of animals that had been

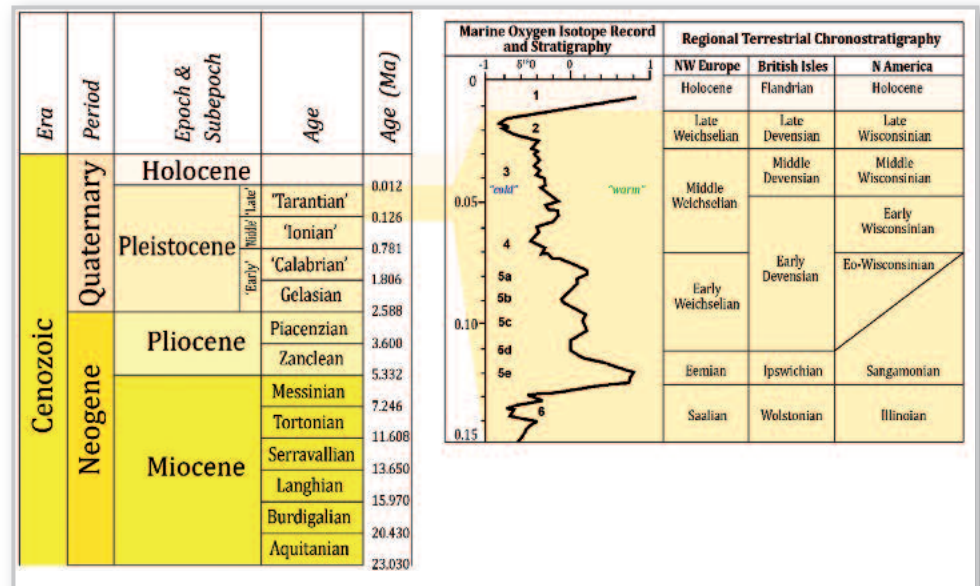


Fig. 3. Time scale of the Pleistocene with alternating glacial and warm periods.

brought to Europe in the past as war elephants or state gifts for the amphitheatres of ancient Rome. Equally widespread was the assumption that they were the remains of animals that had been washed ashore by the biblical great flood.

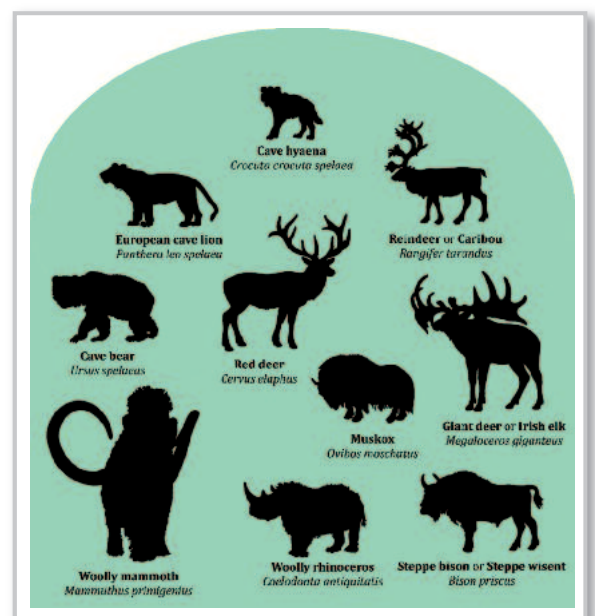
The Georgia Augusta and its Ice Age Mammals

This was also the period of the founding of Göttingen University in 1737. Less than 20 years later, professor Samuel Christian Hollmann (1696–1787) was already taking an intense interest in the remains of large ice-age mammals. Around 1750 he received the first remains from the southwestern edge of the Harz mountains, particularly those of the woolly rhinoceros, but also woolly mammoth bones. Later he obtained further mammoth material from the Harz, but only commented indirectly on its origin (in 1776) by endorsing a thesis according to which the 'mammoth bones' found in the Great Tartary and Siberia were the remains of former war elephants [1, 4].

A significant role in disputing the two above-mentioned assumptions about the provenance of the elephant remains discov-

ered in Europe was played by Johann Heinrich Merck (1741–1791). In a short work *Über den Ursprung der Fossilien in Teutschland (On the Origin of Fossils in Germany)* in 1784 he explained these assumptions to be untenable with very detailed, well-founded arguments. The years that followed were marked by lively discussions about the differences between the distinct teeth of modern and fossil elephants by the leading anatomists in this field at the time, Johann Friedrich Blumenbach

Fig. 4. Mammal faunal elements of the ice-age Mammoth Steppe, a hybrid of steppe and tundra vegetation, in the Eurasian Pleistocene. From v. Koenigswald (2002), modified.



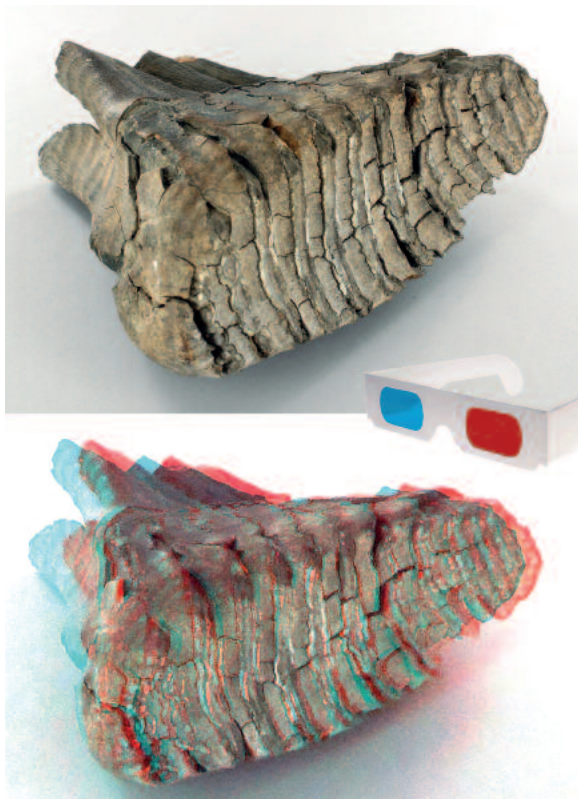
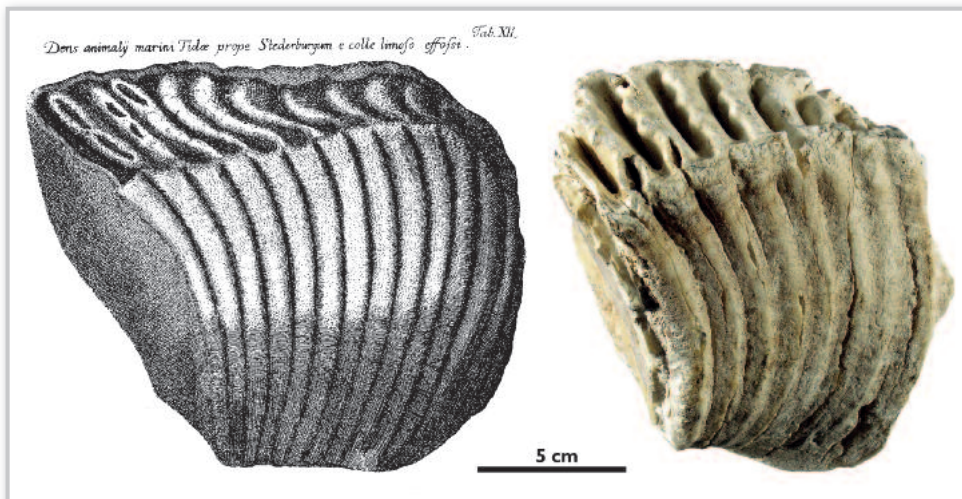


Fig. 5. Lower left molar of a woolly mammoth from western Siberia. A gift from Baron Georg Thomas von Asch to Johann Friedrich Blumenbach at the end of the 18th century. Photographic images – 2D and stereoscopic pictures (anaglyph image) – as part of the project 'Johann Friedrich Blumenbach – Online'. (Geoscience Museum Göttingen)

Fig. 6. Probably lower left first molar (m1) of *Mammuthus primigenius* from the collection of Gottfried Wilhelm Leibniz – discovered in the mid-17th century in Salzgitter-Thiede. Some of the front lamellae have unfortunately broken off in the course of time. In his *Protogaea*, published posthumously in 1749, Leibniz still described it as the "tooth of a marine animal". (Geoscience Museum Göttingen)



Research: Establishing the Age of Bone Material

Radiocarbon dating, also called the ^{14}C dating method, is a technique for radiometrically determining the age of materials – above all organic ones – that contain carbon. Developed in 1946, the method is based on the decline, according to the law of decay, of radioactive ^{14}C atoms bound into dead organisms. This technique can be used for ages between approx. 55,000 and 300 years. Dating carried out on the collection material described in the text yielded the following ages (years B):

- Mummified skin and hair from the 'Adams mammoth' from the Lena Delta from the Blumenbach collection: $34,450 \pm 2,500$
- Molar tooth from Salzgitter-Thiede from the Leibniz collection: $34,240 \pm 200$
- Molar tooth from Osterode from the Blumenbach collection: $34,340 \pm 230$ [5]

(1786, 1788, 1791), Petrus Camper (1788), J. H. Merck (1786) and Georges Cuvier (1796) [1].

It was finally Blumenbach (1752–1840), adjunct professor from 1776 and full professor from 1778 as well as junior custodian (later senior custodian) of the Royal Academic Museum in Göttingen, who was the first to name the African elephant (*Loxodonta africana*) scientifically as a separate species. Two years later, he distinguished the woolly mammoth from the modern elephant species by designating an independent species (Blumenbach 1797, 1799) [1].

Blumenbach's research benefitted from the collection material that he already possessed when he

came into office, along with numerous additional mammoth remains which he had been able to gather together primarily through his large, scientific network and by picking things up himself. This included bone material of a famous Swiss 'giant finding' (the Giant of Reiden) from 1577 (Blumenbach 1788), which is, unfortunately, missing today, along with what is probably a mammoth milk molar which formed part of the

Research: DNA Analyses of Mummified Mammoth Material

Various molecular-biological techniques can be used to clarify genetic changes and questions of kinship, gender, diseases, etc. With advancing technology, and since the sequencing of ancient DNA became more efficient in the 1990s, *Mammuthus primigenius* in particular has developed into a standard model for molecular systematics.

- The sequences gained from skin and hair material from the 'Adams mammoth' has been stored in the 'GenBank database' under the number EU153445 [6]



Fig. 7. Piece of skin of the mummified carcass of *Mammuthus primigenius*. Discovered in the Lena Delta in 1799, but not excavated and transported to St. Petersburg until 1806.

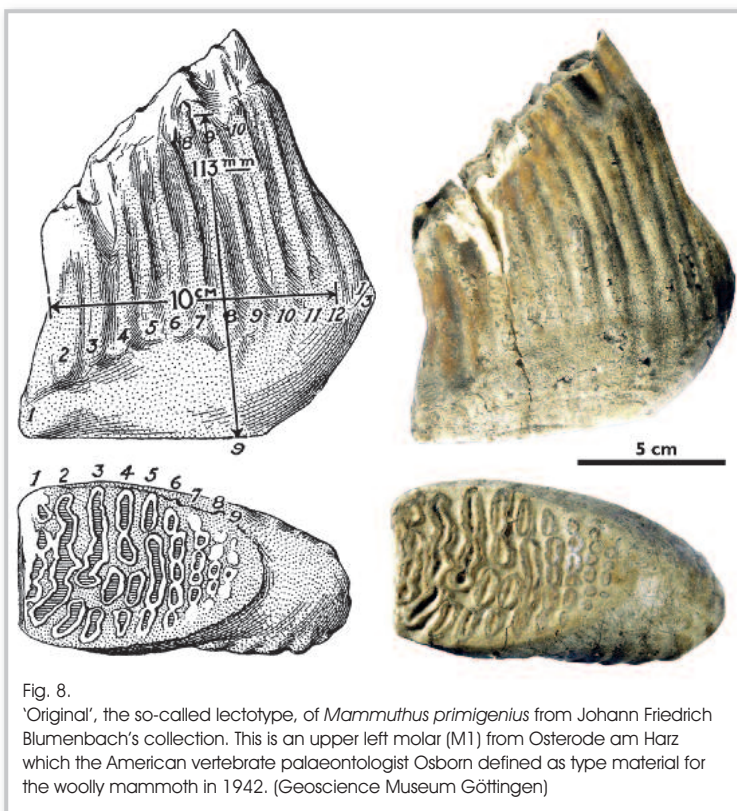


Fig. 8. 'Original', the so-called lectotype, of *Mammuthus primigenius* from Johann Friedrich Blumenbach's collection. This is an upper left molar (M1) from Osterode am Harz which the American vertebrate palaeontologist Osborn defined as type material for the woolly mammoth in 1942. (Geoscience Museum Göttingen)

ice-age mammal remains excavated in 1663 near Quedlinburg, and which were used by Otto von Guericke (1602–1686) for his famous unicorn reconstruction. In the collections of the Centre for Geosciences of the University of Göttingen, western Siberian material is still to be found. This was a gift from alumnus Baron Georg Thomas von Asch (1729–1807) and includes a molar tooth which Blumenbach presents in his 1797 *Abbildungen naturhistorischer Gegenstände (Illustrations of Natural History Objects)*, in which he still wrongly describes it, however, as that of an Asian elephant (Fig. 5). An additional molar, found in Thiede near Salzgitter, which was integrated into the Göttingen collections in 1777 as part of the acquisition of a collection from the Royal Library in Hanover, is from the natural history cabinet

of the polymath Gottfried Wilhelm Leibniz (1646–1716). It was the original from which an illustration was made in his famous, posthumously published in 1749 *Protogaea, or A Dissertation on the Original Aspect of the Earth and the Vestiges of its Very Ancient History in the Monuments of Nature* (Fig. 6).

The ‘Original’ Woolly Mammoth

When in 1799 a mummified mammoth was found in the Siberian permafrost and retrieved in 1806 (the ‘Adams’ or ‘Lena’ mammoth), Blumenbach, as one of the leading experts, was so esteemed that one of the first reconstruction drawings of this animal (Fig. 1) and samples of skin and hair (Fig.

7) were made available to him for his collection. From numerous, primarily German find sites, Blumenbach obtained fossil elephant material to further supplement his collection at the beginning of the 19th century.

A bone bed of ice-age mammals discovered between Osterode and Dorste (am Harz) in the spring of 1808 provided Blumenbach with additional, extensive woolly mammoth material (Blumenbach 1808) as well as with food for lively discussion in his correspondence with Johann Wolfgang von Goethe (1749–1832). A molar tooth from this find complex (along with a second one from Siberia) was drawn in the middle of the 20th century by the

then very famous American vertebrate palaeontologist Henry F. Osborn (1857-1935) and defined as type material for the species *Mammuthus primigenius* (Fig. 8) [1, 5]. This was done according to the practice of the International Commission on Zoological Nomenclature (ICZN), which had not existed in Blumenbach’s day.

When these pieces could not be located in the 1980s, they were considered to have been lost in the Second World War and a so-called neotype was established by Russian Scientists. In the course of work done on the Göttingen collections over the last eight years, however, one piece of the unlabelled type material was rediscovered (Fig. 8) [1, 5]. ◀

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Dr. Mike Reich, born in 1973, studied geology, palaeontology, zoology and chemistry at the University of Greifswald, where in 2000 his diploma work on microfossils won the Pomeranian Science Prize. He received his doctorate with distinction from the University of Innsbruck in 2002, and after various museum and curator positions came to the University of Göttingen in 2003. Since 2004 he has been curator of the Geoscience Collection. Between 2006 and 2009 he held the position of interim professor in Göttingen as well as guest lecturer at the universities of Hanover and Xi’an (China). In total he has more than 100 scientific publications to his name.



Dipl.-Geowiss. Alexander Gehler, born in 1978, studied geosciences with specialisations in palaeontology, zoology and geophysics in Göttingen. His early work experience included internships in various museums as well as student assistantships. After completing his diploma work on ice age mammals in the geoscience collections he was employed at the Geoscience Museum, where he was among other things responsible for the conception and implementation of several special exhibitions. Since 2009 he has been working on a Ph.D. in the isotope geology division of the Geoscience Centre.

Acknowledgements

The authors would like to express their gratitude to Dick Mol (Natural History Museum of Rotterdam) for the fruitful discussions and

Johannes van der Plicht (University of Leiden and University of Groningen) for the AMS ¹⁴C dating of the above-mentioned material.

The Geoscience Museum and its Collections

The Museum of Geological Sciences of the University of Göttingen, also called the Geoscience Museum, is one of the few museums in Lower Saxony with publicly accessible exhibition areas on topics related to geology, mineralogy and palaeontology.

The roots of the Geoscience Collections in Göttingen go back to an initial natural history cabinet from the time of the university's founding in 1737. In later years these collections were exhibited at the 'Royal Academic Museum' (1773–1840) as well as the city's 'Natural History Museum' (1877–1929), all the while continuing to expand in breadth and depth. The separate sections and museums into which the different geoscience collections had long been divided (e.g. the 'Mineralogical Museum' and 'Museum of Geology and Palaeontology') were brought together into one unit – the 'Geoscience Museum' – in 1999/2001.

The main focuses of the Göttingen Geoscience Collections are: (1) the collection of types and original specimens – covering more than 100,000 palaeontological, biological and mineralogical items and series – on more than 3,000 publications since 1724; (2) geoscience collections significant from a historical perspective, including the collections of Gottfried Wilhelm Leibniz (1646–1716) and Johann Friedrich Blumenbach (1752-1840); (3) the meteorite collection, founded in 1777 and expanded over the course of time, with more than 400 findings from around the world in 1,500 individual pieces; (4) the amber collection, including the former 'Königsberg Amber Collection'; (5) collections on the regional geology of Lower Saxony, Germany and Europe; (6-7) the extensive systematic palaeontological and mineralogical collections from all over the world, along with (8) the

collections related to the study of fossil lagerstätten, currently very much in demand for research.

Thanks to their steady expansion over three centuries, these collections currently make up more than four million objects and series in the Centre for Geosciences alone, making the University of Göttingen home to the fourth largest geoscience collection and the largest university geoscience collection in Germany.

Alongside the permanent exhibits, the Geoscience Museum presents varying special exhibitions on a whole range of topics. Researchers from the Faculty of Geoscience and Geography are involved in numerous international research projects across the globe. This enables us to keep presenting you with the latest findings from current research, alongside the public collections and special exhibitions.

Mike Reich



Photo:
Frank Stefan Kimmel

Talking Heads

Unearthing the Stories Behind the Skulls in Blumenbach's Collection

Michael Schultz

The Göttingen Skull Collection established by Johann Friedrich Blumenbach, professor of medicine at the University of Göttingen from 1776–1840, is probably the oldest preserved university skull collection worldwide. Blumenbach is widely considered one of the most important natural scientists of his time, and as one of the last universal scholars he did research in the various fields of medicine, zoology, paleontology, mineralogy and ethnology. He is called the 'Father of Anthropology' and was the 'First Comparative Anatomist'. His skull collection is based upon approximately 300 skulls which he partly used to write his thesis in 1775 entitled

De generis humanis varietate nativa (On the natural varieties of the human species). There, he described the natural, i.e. biological diversity of the morphology of humankind, and differentiated between five principal morphological varieties of anatomical man. It is important to know that he did not establish a racial ideology; however, this was frequently alleged. The five skulls representing prototypes of the anatomical varieties are still today part of the Blumenbach Skull Collection of the Department of Anatomy (Figs. 1 and 2).

During his academic career, Blumenbach continually received human skulls from scholars, friends

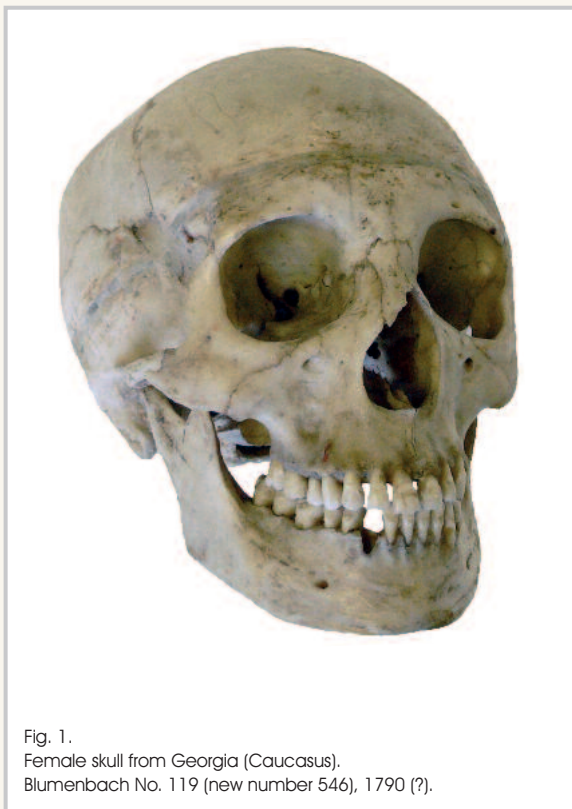


Fig. 1.
Female skull from Georgia (Caucasus).
Blumenbach No. 119 (new number 546), 1790 (?).

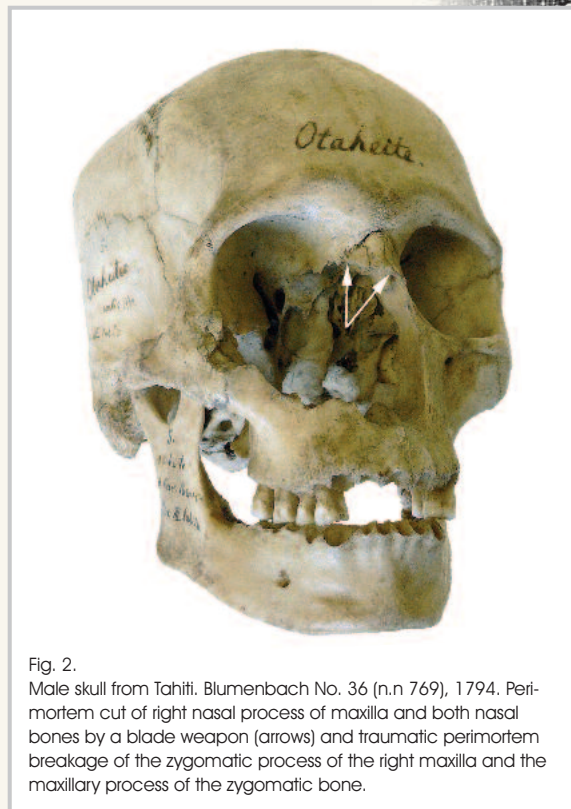
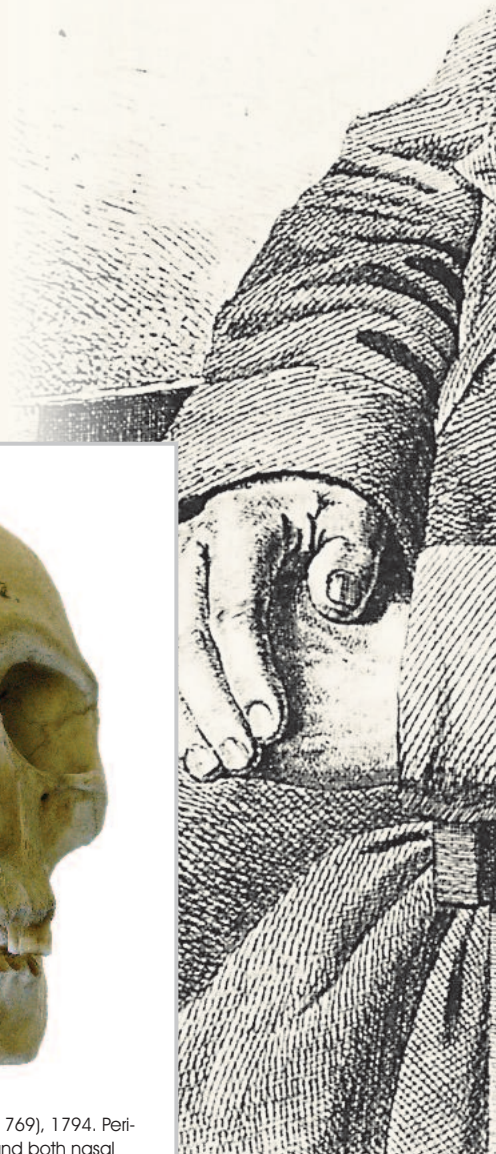


Fig. 2.
Male skull from Tahiti. Blumenbach No. 36 (n.n. 769), 1794. Perimortem cut of right nasal process of maxilla and both nasal bones by a blade weapon (arrows) and traumatic perimortem breakage of the zygomatic process of the right maxilla and the maxillary process of the zygomatic bone.





L. E. Grimm fec. ad vivum Cassel. 1823.

J. F. Blumenbach



Fig. 3.
Head of an Egyptian mummy.
Blumenbach No. 25 (n.n. 641), 1796.

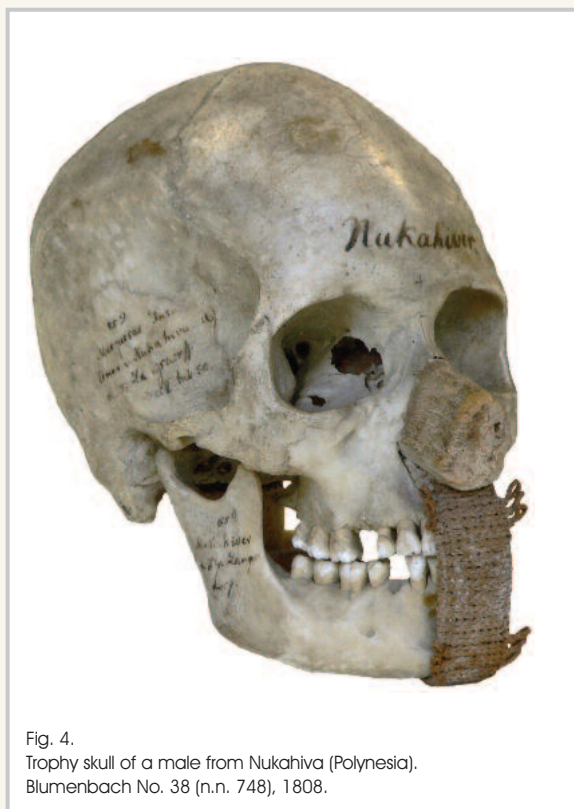


Fig. 4.
Trophy skull of a male from Nukahiva (Polynesia).
Blumenbach No. 38 (n.n. 748), 1808.

and colleagues, including Sir Joseph Banks, Baron Georg Thomas von Asch, Alexander von Humboldt, Johann Wolfgang von Goethe and Franz Joseph Gall. As Blumenbach was a member of the Medical Faculty and the content of the collection clearly belonged to the scientific field of anatomy, the skulls along with other constituent parts of Blumenbach's collections were bought after his death in 1840 by the University of Göttingen. The anatomist and surgeon Konrad Johann Martin Langenbeck (1776–1851) integrated the skull collection into the collections of the Institute of Anatomy, and it was subsequently supplemented by Langenbeck's successors, including Jacob Henle and Friedrich Merkel.

There had been a comprehensive catalogue containing detailed descriptions of the exhibits which also included the results of several anthropological investigations (e.g., Wolfgang Hauschild). Unfortunately, this catalogue burnt at the end of World War II when the 'Anatomical Theatre', as the Institute of Anatomy was called, was destroyed by bombs. Fortunately the skull collection survived thanks to Erich Blechschmidt, the director of the department at that time, who relocated the skulls to the small village of Bremke outside Göttingen. For most of the collection, therefore, very little information exists; on a few skulls, however, there are some short descriptions written by Blumenbach which give us some insight into their origin. In addition, some years ago a project was established that deals with the estate of Blumenbach's letters and hand-written texts, which might shed some light upon the origin of the other skulls. Additionally, several skulls were re-examined with main emphasis on pathological changes (cf. Figs. 2, 6-8) by the paleopathology research group at the

Department of Anatomy. Today, the Blumenbach Skull Collection is part of the collections of the Department of Anatomy of the University of Göttingen and contains approximately 850 skulls and casts.

The Scientific Impact of the Blumenbach Skull Collection

The scientific value of the Blumenbach Skull Collection is beyond dispute. The collection includes not only anatomically, but also anthropologically, archaeologically, ethnologically and historically interesting exhibits. For instance, the Bavarian King Ludwig I gave Blumenbach an ancient skull excavated in a tomb of the Etruscan necropolis at Tarquinia in 1834. Furthermore, the collection includes an ancient Egyptian mummy head which probably was dissected by Blumenbach himself (Fig. 3). Originally, this head was in possession of the Royal Society of London and was given to Blumenbach by Thomas Turner in 1796. Even Goethe contributed exhibits to this collection. For instance, when Goethe returned from his second trip to Italy, he provided Blumenbach with a cast of the skull of the famous Italian painter of the High Renaissance, Raffaello Santi. However, the allocation of the skull from which the cast has been made is problematic.

Interesting exhibits of ethnological interest are a Polynesian skull from Nukahiva (Fig. 4) and a Melanesian skull from New Caledonia (Fig. 5). At first sight, both skulls show the same morphological feature: an artificial wooden 'nose'. However, the skull from Nukahiva is a trophy skull and has a rough wooden plug in the anterior bony aperture of the nose which is completely blocking this opening (in this skull, also the mouth is closed by a kind of bandage), while the skull from New Caledonia is an ancestor skull and shows a stylised wooden

nose which is carefully carved, has an opening for some decorative elements (e.g. feathers) and is fixed in the median plane of the nose aperture. Additionally, the base of the Polynesian trophy skull had been broken to enlarge the occipital foramen, probably to remove the brain. This traumatic lesion suggests cannibalism, something that has been found in skulls dating all the way back to Neanderthal times. As for the artificial 'noses', there are two different theories. In the case of the trophy skull, the owner of this skull was probably trying to protect himself from the victim's spirit by closing the nose and the mouth. In the case of the ancestor skull, the artificial nose was probably thought to make the skull complete and thus more aesthetically pleasing.

The Blumenbach Skull Collection is also of current medico-historical interest (Schultz 2007; Schultz and Kuhn 2001), in particular the pathological aspects currently being studied by the paleopathology research group. Many of these skulls, for instance, exhibit vestiges of diseases caused by deficiency (e.g. scurvy) or infection (e.g. syphilis). A few skulls which came from South-East Asia (e.g. Burma) exhibit the rare features of anemia (Fig. 6), which might be due to malaria. Interestingly, all of these skulls date to before the development of antibiotics. Therefore, the morphological features which are observable in this collection and which are characteristic of various diseases are, as a rule, completely developed without limitation due to antibiotic treatment and teach us today about the pure morphology of lesions characteristic of such diseases.

There are also skulls which reveal vestiges of violence (e.g. blunt trauma, surgical procedures). Here, two examples stand out. The first case is a skull from Melanesia (Fig. 7) which, accord-

ing to a small label, was brought to Europe possibly by the explorer Captain James Cook. This is a skull of a juvenile male which exhibits vestiges of blade weapons (e.g. a European sabre). The young islander did not survive these blows (Fig. 8: black arrows), one of which caused a gaping crack in the skull (Fig. 7: white arrows). The second case represents a trepanned skull from Russia that Blumenbach received from Baron von Asch who was at that time a military surgeon of the Russian Tsar at St. Petersburg (Fig. 8). The skull vault of this adult male shows two scars which are closely situated left to the sagittal suture (the seam running between the skull's two halves) and represent the remnants of a blunt trauma (Fig. 8: arrows). This trauma probably damaged a blood vessel of the meninges, and since as a rule such bleeding is fatal without surgical intervention, an operation was necessary. The difficulty of such an operation in this case would have been its location close to the sagittal sinus, an important venous blood conduit situated just below the sagittal suture. If the operator had damaged the sinus, this 18th-century patient would most certainly have died. Fortunately, as the morphology of the operation wound illustrates, this patient survived for many years, leading to the conclusion that the operator must have been an exceptionally gifted surgeon. The operation itself was performed using a cranial trepan, a surgical instrument shaped like a crown which creates a round hole by rotation. Described as far back as Hippocrates' texts written in the 5th century B.C., similar instruments are still in use today. However, as the results of paleopathological investigations on ancient skulls show, the mortality rate due to this technique was a relatively high 25 to 50% (Schultz 1993). As Figure 8 also demonstrates, several years after the op-



Fig. 5. Ancestor skull of a male from New Caledonia (Melanesia). Old No. 523 (n.n. 740), 1880.



Fig. 6. Male skull of a Burmese exhibiting severe changes due to anemia (porotic hyperostosis). Blumenbach No. 120 (n.n. 589), 1832.

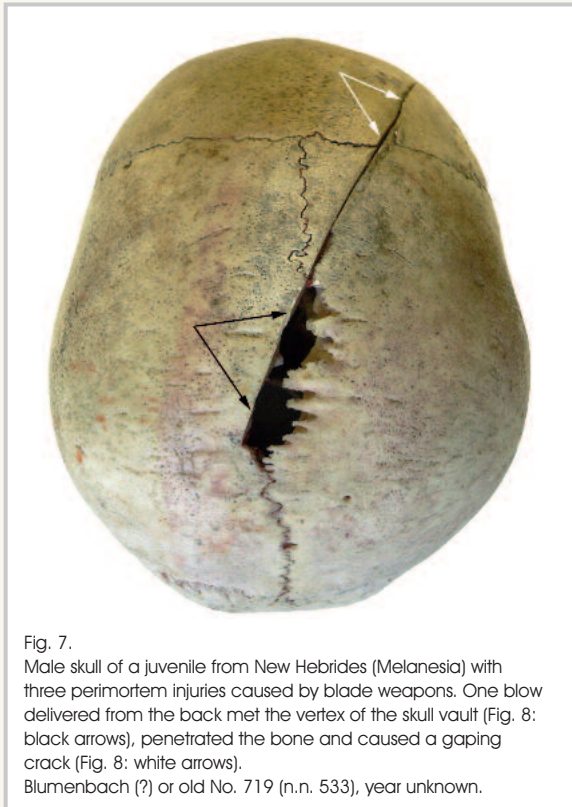


Fig. 7.
Male skull of a juvenile from New Hebrides (Melanesia) with three perimortem injuries caused by blade weapons. One blow delivered from the back met the vertex of the skull vault (Fig. 8: black arrows), penetrated the bone and caused a gaping crack (Fig. 8: white arrows). Blumenbach (?) or old No. 719 (n.n. 533), year unknown.

eration this individual suffered from a severe inflammation of the scalp, which eventually healed up after ravaging the external surface of the skull vault (Fig. 8a).

The Blumenbach Skull Collection thus contains important reference cases that are valuable for research across a wide variety of fields, including paleopathology

(deficiency and infectious diseases in the past), forensic anthropology and legal medicine (trauma, scalping) and the history of medicine (surgical interventions). These cases inform us about the nature and the etiology of diseases as well as the abilities – and inabilities – of medical doctors in earlier days. ◀

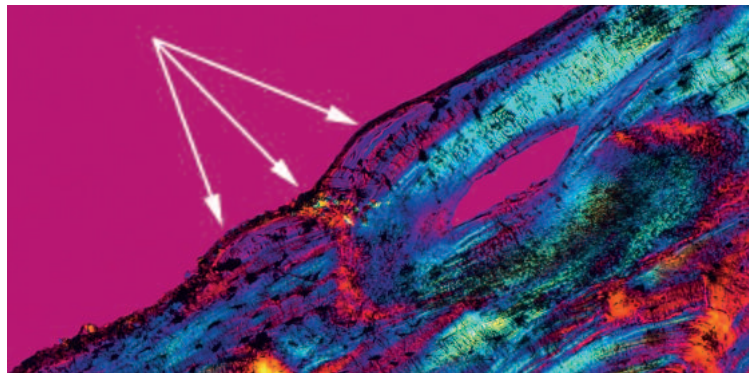


Fig. 8a.
Cross section through the external surface of the skull of a Russian (same as in Fig. 8). Vestiges of scarring (arrows) after severe scalp infection. Undecalcified thin ground sections (thickness 70µm) viewed through the microscope in polarised light using a hilsubject red 1st order (quartz) as compensator. Magnification 100x.

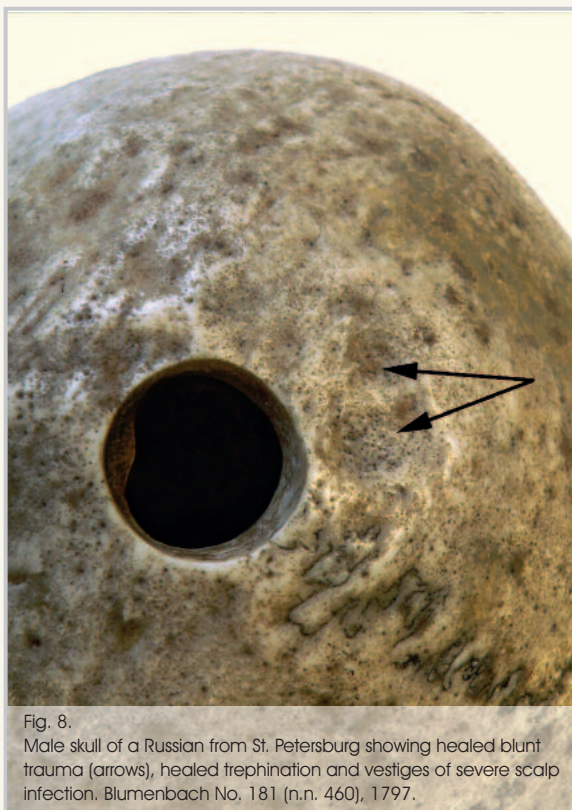


Fig. 8.
Male skull of a Russian from St. Petersburg showing healed blunt trauma (arrows), healed trephination and vestiges of severe scalp infection. Blumenbach No. 181 (n.n. 460), 1797.



Prof. Dr. Dr. Michael Schultz studied biology, medicine, early and proto-historic archaeology and ethnology. He completed a Dr. med. in 1977 and a Dr. phil. nat. in 1979 at the University of Frankfurt am Main, and completed his habilitation in 1988 at the University of Göttingen. He is a physician, biological anthropologist and professor of anatomy in the Centre of Anatomy at the University of Göttingen, and he has been curator of the Blumenbach Skull Collection since 1980. He has also been a visiting professor at numerous universities including Hamburg, Basel, Vienna, Mexico City, Bradford (UK) and Cairo. From 1996–2000 he was President of the German Society for Anthropology, and from 2001–2003 President of the American Paleopathology Association. His major research interests revolve around the evolution and the history of diseases and the influence of environmental factors on prehistoric and early historic populations, and in the course of his research he has carried out field-work across the globe.

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Secrets of the Bog Bodies

Bog bodies are naturally preserved human corpses found in the sphagnum bogs of Northern Europe. As archaeological skeletons and mummies they are also bio-historical documents, giving us insight into the lives of people who lived long ago. But how can we find out what they have to say? For this we need the methods and techniques of paleopathology, a relatively new scientific field situated at the convergence between medicine, physical anthropology and archaeology. Paleopathology explores the nature, the scope and the frequencies of diseases within an ancient population. The results of an extensive paleopathological investigation allow, of course within certain limits, to reconstruct the biography of an ancient individual. This was performed in the context of a scientific project initiated by the State Archaeologist of Lower Saxony and carried out by the Universities of Hamburg and Göttingen. Most of the bog bodies date back to the Iron Age. At this time, however, cremations were common. As cremated bones give relatively little information on the dead person and their living conditions, bog bodies represent a rare and valuable find for archaeologists. The most interesting case of a bog body from northern Germany is presented here.

In 2000 the bog body of 17-19-year-old female, named 'Moora' by the archaeologists, was excavated in the Uchter Moor south of Hamburg. Beginning in childhood this young female had undergone several phases of arrested growth, possibly caused by malnutrition or infectious diseases. Her skeleton is exceptionally well preserved, also in its microstructure (see figure). Two healed impression fractures on the external surface of the

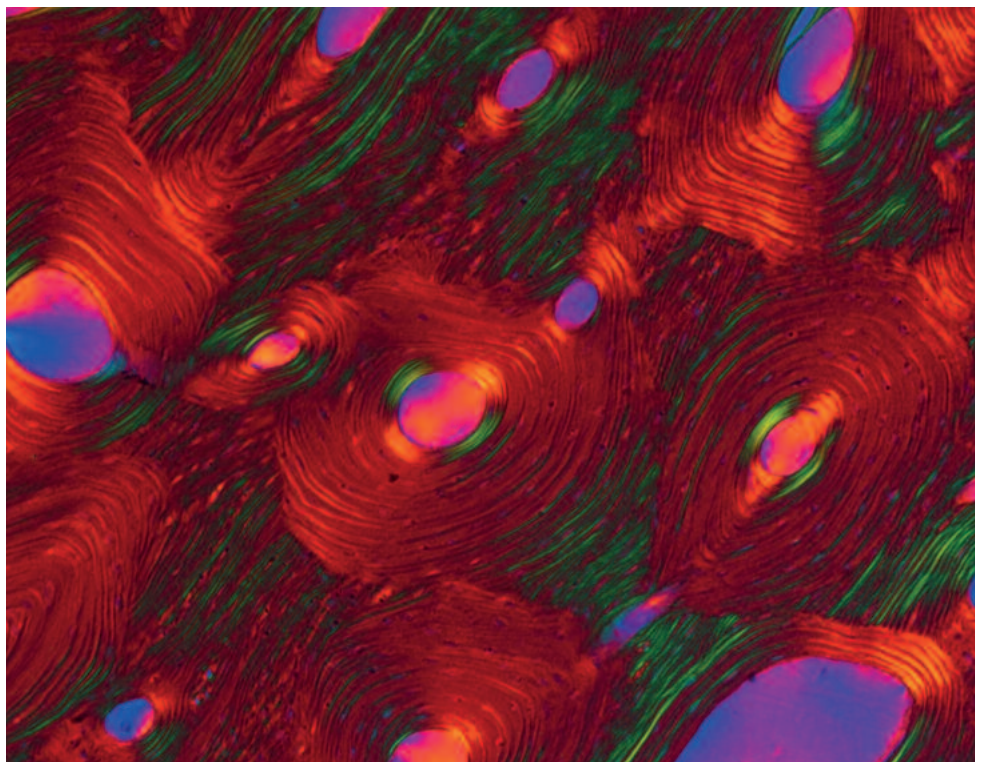
frontal bone due to blunt skull trauma document rough living conditions. On the skull base sits a small spongy tumor, which might have been the cause of her death. On the endocranial surface of the skull, vestiges of meningeal reactions are visible (probably tuberculous meningitis). Porotic orbital roofs represent an inflammatory process which was induced by penetrating chronic sinusitis frontalis (inflammation of the sinuses). Vestiges of inflammatory processes in the nasal cavities, on the adjoining surface of the external nasal aperture and the intraorbital surface of the upper jaws complete the impression of unpleasant living conditions. Also the postcranial skeleton tells us about the labored and painstaking

life of this young female. Her spine was slightly scoliotic (crooked) and in the upper back moderately kyphotic (hunched), probably due to inadequate physical strength. Furthermore, pathological alterations in the form of longitudinal striation on the surfaces of the long bones of the legs suggest chronic nutritional deficiency (e.g. scurvy) or infectious diseases. Several months before her death, 'Moora' also suffered from a traumatic lesion of the pelvic sacroiliac joint.

Although we have evidence of many diseases 'Moora' suffered from, we do not know the cause of her death 2650 years ago. Quite possibly, she just became a sudden victim of the moor.

Michael Schultz

Cross section through left femur of the bog body 'Moora'. Compact bone substance. Undecalcified thin ground sections (thickness 50µm) viewed through the microscope in polarized light using a half-wave plate (quartz) as compensator. Magnification 200x.



Pictures at an Exhibition

Collection Re-Opening Offers Unique Learning Opportunities

Anne-Katrin Sors



Since the beginning, the primary mission of the University of Göttingen's Art Collection has been to serve educational purposes. Thanks to its dedicated rooms on the second floor of the University's Old Auditorium, though, it has also been possible to make the collection's valuable inventory of paintings and sculptures permanently accessible to the public – an important consideration given its status as Göttingen's only picture gallery. The very extensive collection of drawings and prints allows for constantly-changing special exhibitions covering a wide range of periods, regions and subjects.

One main purpose of the Art Collection is not only to use originals for teaching purposes in at the

Department of Art History, but also to allow students to engage with all aspects of the work that museum collections entail. This mission is realised most obviously in the specific practice-orientated seminars and internships offered during the semester breaks. Here, students of art history are given the opportunity to work directly with and on original works of art and to design, plan, organise and even run exhibitions themselves.

Due to construction work, the Art Collection was closed from 2008 to 2011. This made setting up the new arrangement of paintings and sculptures in preparation for the reopening in April 2011 particularly challenging. In the final stage, 13 students completed

internships; from February until the exhibition reopened in April, they were not only involved in hanging artwork but also first had to coordinate the transport of all the paintings and sculptures from the interim storage rooms in the historical building of the Göttingen State and University Library (SUB). Although a professional service specialised in art transport was in charge of the move, a lot of work still had to be done; for example, it took three days just to remove the professional transport packaging from all the art.

The intent was to hang pieces of art according to a new system that contained works not previously exhibited. The initial con-



Photo: Peter Heller

cept for this structure had to be developed while simultaneously paying attention to conservation status and new conservational techniques. Scholarly research was required to draft, write and affix the labels and text panels. We launched our PR campaign with newly designed and rewritten flyers and posters, advertising on the web, and a press conference with a media kit containing text and photographic materials. Finally, several tasks remained: address lists had to be updated, invitations sent, missing labels affixed, bottles of wine and biscuits purchased and served at the reception, not to mention the organising and running of the supervisory and information services.

One example of all the planning it took concerned the decoration of the exhibition space. The process to select the colours for the movable walls that depict the collection's thematic categorisation took us as far as galleries in Kassel and Braunschweig. There, we discussed the colour schemes available for museums and how the colours would affect the presentation of paintings and sculptures; then we matched colour guides before making the final decision on the colours for our walls.

All this rearranging took place alongside normal business operations. For instance, several of the interns took time in between to tend to questions regarding loaner items, i.e. tasks ranging from sci-

entific enquiries on the pieces in question, determining the amount of insurance to be taken out and drafting loan agreements to organising the art's transportation. The climatic conditions in the shipping crates and low-vibration transport vehicles were just some of the many details to be considered. Seemingly trivial but time-consuming things like determining the luminance for particularly delicate pieces and controlling the microclimate in the rooms were also crucial tasks.

The day-to-day operations of a museum – including tasks such as answering loan requests and scientific enquiries, locating old files and photos, etc. – in itself provides students with ample educa-

tional content. The rare but special case of setting up an art collection virtually from scratch required even more effort, but also gave a large circle of dedicated students a unique opportunity to become familiarised with the unusually broad range of demands associated with museum work.

We plan to continue in this educational tradition by initiating a large-scale special exhibition project. The Göttingen Art Collection boasts 130 drawings and three sketchbooks of Eduard Bendemann

(1811–1889), a pupil of Wilhelm Schadow (1788–1862) and member of the Düsseldorf School of Painting. These items were the subject of two seminars that lecturer Dr. Christian Scholl and I conducted. Before the seminars two-thirds of the artist's draft sketches were without context; afterwards, the students were able to assign a number of the sketches to certain paintings – a remarkable research outcome. These works – which have remained to date widely unknown to both researchers and

the public – are now being prepared within the framework of the planned exhibition. It will require a high degree of student participation to scientifically prepare the works, exhibit them and document them in an accompanying publication. Furthermore, the collection is in dire need of a comprehensive inventory, something unfortunately neglected by my predecessors but essential to ensure that all the collection's treasures will have the chance to be studied, prepared and exhibited in the same fashion. ◀



Photo: Peter Heller

The University Art Collection

The University of Göttingen's Art Collection dates all the way back to the school's founding – making it not just one of the oldest cultural institutions in the city, but also the oldest university art collection created for teaching purposes in Germany.

The initial collection was formed from two key benefactors.

In 1736, Frankfurt patrician Johann Friedrich Armand von Uffenbach decided to bequeath his expansive collection of etchings and drawings to the new University. They were moved to Göttingen following his death in 1769. The second donation – of about 270 paintings – came thanks to Johann

Wilhelm Zschorn, secretary of the higher court of appeals in Celle. The works arrived in Göttingen in 1796 atop five horse carriages and packed in 80 chests. Christian Gottlob Heyne, head of the university library, appointed Johann Dominicus Fiorillo – a painter – as the collection's first curator. He

not only recorded the entire collection of paintings and graphics manually in inventory books, he also created the first catalogue of paintings, which was printed in 1805. The inventory books still form a basis for all research.

The collection was then continually expanded, primarily through donations as well as select purchases, which were often supported by the University Association or Monastic Chamber of Hanover. Sculptures and even video art have enriched the collection over the centuries. In 1926, Wolfgang Stechow performed extensive research and created the first catalogue raisonné of the paintings. It has since been enlarged, primarily through the purchase of works from exceptional Italian painters. Although Wolfgang Stechow was driven out of Germany by the Nazis, he remained faithful to the

University of Göttingen – and particularly its art collection – from his new home in the U.S. He continued to contribute his scientific findings and donated his collection of etchings and drawings. Thanks in large part to these important drawings and etchings, the collection is now highly respected. Requests for loans and research visits come regularly from both Germany and abroad.

The collection's paintings and sculptures were originally kept in Fiorillo's apartment and were later moved to a number of locations, including the Accouchierhaus, once a maternity clinic. In 1988, the Old Auditorium at the Weender Tor became their permanent home – the perfect place for exhibiting the permanent collection as well as holding special exhibitions. Teaching plays a key role for every area of the collec-

tion. Art history students are given the opportunity to work directly with original works of art and help develop exhibition concepts.

The collection now includes 15,000 etchings, 2,500 drawings, 300 paintings, 100 sculptures and 150 artist videos. The painting collection is focused on the Golden Age of Dutch and Flemish painting but includes 19th- and 20th-century works by Kaulbach, Gurlitt, Modersohn-Becker, Pechstein and Grieshaber as well. The etchings include groups of works by Dürer, Rembrandt and Goltzius as well as single pieces by Goya, Heckel, Liebermann, Pechstein and other renowned artists. A drawing by Sandro Botticelli and original printing plates from Rembrandt are among the collection's highlights.

Anne-Katrin Sors

275th Anniversary Calendar on Sale



In preparation for the celebration of its 275th anniversary, the University of Göttingen has produced a calendar entitled "Treasures of Göttingen University". Thirteen vibrant photos depict valuable rarities and ground-breaking inventions from the University's collections, museums and gardens. These include, among other things, the Gauß-Weber telegraph, the giant water lily 'Victoria cruziana', and the Göttingen Gutenberg Bible. Also included are historic sites such as the Historical Observatory, the Paulinerkirche and the student detention rooms in the Aula building. These treasures were artfully photographed by Frank Stefan Kimmel.

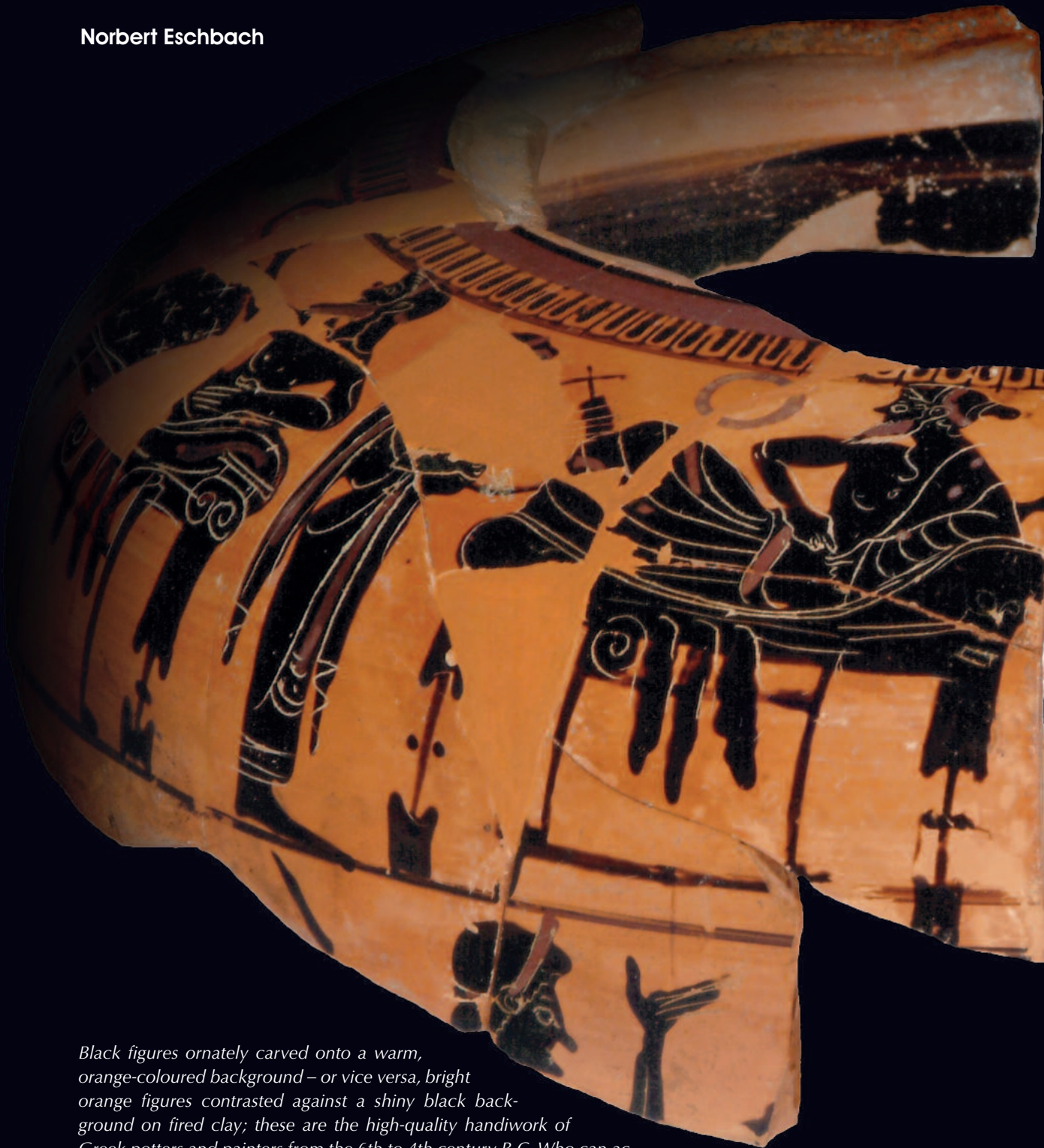
The calendar measures 40x60 centimetres and costs €19. It is available for purchase in Göttingen's bookstores, tourist information centre in the Old City Hall and in the University Shop in the Central Lecture Hall (ZHG) at Platz der Göttinger Sieben 5.



The Shard Connections

Göttingen's Place in the Ancient Greek Pottery Network

Norbert Eschbach



Black figures ornately carved onto a warm, orange-coloured background – or vice versa, bright orange figures contrasted against a shiny black background on fired clay; these are the high-quality handiwork of Greek potters and painters from the 6th to 4th century B.C. Who can actually claim to have held such treasures in their hands? Students at the University of Göttingen can! The University of Göttingen's Archaeological Institute not only presides over a comprehensive and distinguished collection of plaster casts, it also possesses rich inventories of original ancient artworks from Egyptian, Etruscan, Greek, and Roman artists. Particularly impressive is the collection of complete vessels and fragments from Greek and southern Italian vase painting.



Fig. 1b. Göttingen K 312 and
National Museum Krakow, Fürst
Czartoryski Museum Inv. 1077
Photomontage
Photo: Stephan Eckardt and
National Museum Krakow

Shards of pottery make up the largest group of finds in any archaeological excavation. 150 years of archaeological research have yielded a chronological system of development for most ancient landscapes that leads to reliable conclusions on the cultural development and interaction of both small and large settlements. Pottery painted with figures offers special insights into societal processes. What was considered worthy of being painted? And what was left out of these depictions? What topics were depicted and when? How was the production process organised? How did the various workshops or even the various painters' styles differ? What was the relationship between the form and function of the individual vessels and the pictures depicted on them, and how do these pictures interact in an archaeological context? These are only a few of the scores of questions that play a role in current vase research. An academic collection of original art is the best way to convey the answers to students.

An original fragment – not just a photograph – can bridge the gap between object and viewer. Things that a photograph cannot reproduce, or not adequately enough, suddenly become visible. The colouring of the pottery, for example, can provide a very accurate indication of the major production areas in the ancient world. If you look at the forms on red-figure vessels from different angles and with different lighting, you will notice that they are not

simply painted lines; they are actually fine, ornate relief lines that were painted using a fine brush to form the contours and internal details. Other lines painted using diluted, nearly transparent colours are difficult to capture with photography. This also holds true for objects and inscriptions in white or red paint, which often wear off or become faded with time; only shadows remain and they can only be seen from specific angles. The close-up impressions and discoveries offered by the original artworks continue to fascinate students.

The *Corpus Vasorum Antiquorum* (CVA), an international six-nation project spearheaded by France, was founded in 1920 after research on Greek vases became more systematic in the late-19th and early 20th century. Belgium, Denmark, Great Britain, Italy, and the Netherlands initially joined the project but political considerations kept Germany from joining until 1935. Today, there are 26 member countries and more than 300 volumes have been published. Germany is now represented by 90 volumes, three of which originated in Göttingen with a fourth to be finalised soon. The objective is to make the inventories of ancient Greek and Italian painted pottery – both small and large collections scattered around the world – as accessible to the public and academia as possible. The features and condition of each vessel and shard as well as their figure depictions must be described in great detail and docu-

mented by photographs. Academic commentaries don't just classify the vases based on the well-known workshops or painters and interpret the pictures depicted on them, they also look at the origins of the objects and how they changed hands over the centuries.

The collection of ancient art at the Göttingen Institute has been – since its inception and initial purchases of antique ceramics – an indispensable instrument for vivid teaching and research even prior to the mid-19th century, which underscores the very reasons for creating these types of collections in Göttingen and elsewhere. Unlike major museum collections, their primary focus was never – and still is not – the public, lessening the pressure to acquire expensive objects that can draw large crowds. The collection was intended to display as many samples of the different genres of ancient art as possible, including all production periods of Greek pottery. Even the tiny shards were welcomed for educational purposes – these pieces were relatively inexpensive to acquire in the early period of art trade and gradually increased in relevance to other fields for more than just research. Many institutes increased their collections of ancient art by making purchases on the Roman art market in the last two decades of the 19th and in the early 20th century. The pottery collection in Göttingen was substantially expanded at this time, too. There are two lists from 1892 and 1897 containing the inventories, which are likely the product of an initiative by Karl Dilthey (1839–1907), who became professor for archaeology in 1889. The 1897 list is titled *Directory of a Collection of Style Samples of Ancient Pottery*. The objects were from Paul Hartwig (1859–1919), an archaeologist who earned a living from trading in ancient art in Rome from 1892 to 1915. He was a serious expert and specialist in Attic red-figure

Fig. 1a.
Fragments of attic
black-figure Stamnos,
Göttingen K 312
Ca. 510-500 BC –
Michigan painter
Photo: Stephan Eckardt



vases. His book entitled *Die griechischen Meisterschalen der Blüthezeit des strengen rothfigurigen Stiles (The Bowls of Greek Masters from the Height of the Pure Red-figure Style)*, published in 1893, greatly inspired publications by Sir John Beazley (1885–1970), a British vase researcher, whose works are still essential to researching 6th–4th century B.C. Greek pottery.

A wide range of signs of wear, which could be indications of usage from either ancient times or more recent times, were documented when the Göttingen vases and fragments were undergoing treatment, in particular during the careful conservation work recently performed by qualified institute conservator Jorun Ruppel. Rather interesting discoveries have been made in the process of examining traces of wear on individual fragments which show that they were not excavated individually but belong instead to a vessel that at one point was intact on the excavator's workbench.

Signs of this are areas of fractures that were filed off, for example. It was a common method of preparation in earlier conservation work. Other clear indications are adhesive residues and blackened colouration that can be traced to an adhesive (shellac), which was long in use. Even pencil markings have been found on the edges of fractured pieces, offering clear evidence that something was corrected on that spot. Unfortunately, it might only be that a part of a vessel or even just a fragment made it to Göttingen. Finding 'dissecta membra', scattered remnants of a vessel that have survived handling, is not only an exciting pastime of vase researchers, it also allows the possibility of reconstructing the silenced depictions on a vessel through its individual pieces to give it a voice again. In some more fortunate cases, the scattered location of the fragments can reveal

additional information about the location it was found and its context. Göttingen's comprehensive compilation of these different types of corrective measures – about 40 have been documented – offers major insight into early art dealing and the interaction between the various actors as well as their 'delivery men', who at times acted unscientifically and in their own self-interest when excavating. Many ancient collections in Germany are closely tied to collections in the U.S., the U.K., France, and, naturally, Italy. Although many of the connections have been known for some time, the meticulous restoration and handling of the Göttingen vessels and fragments led to significant and sometimes spectacular gains.

The half shoulder of a squat vessel depicting a drinking party (Fig. 1a) most likely came from the second of Paul Hartwig's deliveries, in 1897. Adhesive residues (shellac) from various fractures, in particular the filed-down area of the right external fracture, clearly show that more had been found. Dietrich von Bothmer (1918–2009), one of Sir John Beazley's pupils who also worked at the Metropolitan Museum in New York from 1973 to 1990, informed Göttingen about an entire matching shoulder half (fig. 1 b) that was located in the Czartoryski Museum, in Krakow, Poland, in 1979. The prince had purchased the shoulder half in 1884, together with other objects from ancient Greece and Rome, from Florence agent Ricardo Mancini, a landowner who was more interested in

profit than archaeology during digs in the Etruscan necropolis of Orvieto. The treated areas around the fractures prove that those who discovered them knew they belonged together and tried to restore them.

The practice of selling broken fragments separately, even when it was known they belonged together, was not an uncommon event for individual 'excavators' and art dealers in the late 19th century. However, it was new that a vessel, of a part thereof, that had once been pieced together was taken apart again and scattered, whether at the dig itself or from the excavator's own collection.

The fragments of an amphora (Figs. 2a,b), which Paul Hartwig (1897) had also brought to Göttingen, offers another good example of this practice. The four shards were glued back together using a whitish adhesive, of which traces have also been found on the ex-

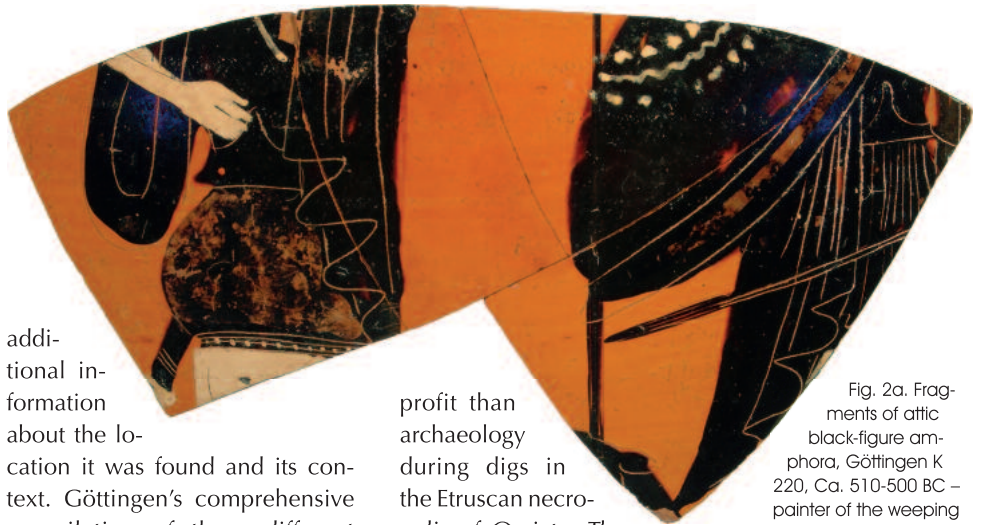


Fig. 2a. Fragments of attic black-figure amphora, Göttingen K 220, Ca. 510-500 BC – painter of the weeping Trojan women
Photo: Stephan Eckardt



Fig. 2b. Göttingen K 220 and Philadelphia, University of Pennsylvania, Museum MS 4843 · Photomontage
Photo: Stephan Eckardt and Philadelphia, University of Pennsylvania, Museum

posed areas along the fracture – yet another clear indication of previous conservation work. It was again Dietrich von Bothmer who provided the decisive clue in 1976: it fits together with a back-side of an amphora in Philadelphia (Fig. 2b), which is barely complete and depicts two Amazons facing off with a large dog between them – of which only a part of the dog’s head remains. Documents in the museum archives specify the previously unknown origin of the fragment in Göttingen: the amphora is from Orvieto and from excavations performed by Ricardo Mancini, which were financed by the museum in Philadelphia in 1896–1897. The finds, including Mancini’s portion, were shipped to Philadelphia in 1898. Although an offer to have the finds restored in Italy was rejected, they had apparently been

conserved at the excavation site. How Paul Hartwig came into possession of the fragments is unclear. It seems plausible that Ricardo Mancini acted alone and sold him the object while the excavations were proceeding without notifying the client. He and Paul Hartwig were already on good terms – he listed about 28 different fragments from his delivery that were “nearly all from Orvieto” in his first sales receipt from 1892.

Previous conservation work in collections around the world demonstrate how extremely dispersed fragments can be. The same names of archaeological dealers turned up repeatedly around the turn of the previous century. They could acquire ‘new’ material at excavations that were in progress and others at liquidation sales of old collections on the Roman art market.

The fragment of the lower part of the body of a small black-figure amphora (Fig. 3a; Hartwig, second delivery from 1897) offers a recently discovered example of this. It depicts a large grazing ibex, with the hind legs of fighting animals in front of its head. It

completes a vessel that was previously only two-thirds intact and housed at the National Archaeological Museum of Florence (Fig. 3b). In 1901 Paul Hartwig sold a second fragment of the vase to the Herzog-Anton-Ulrich Museum in Braunschweig, which has now been returned to Florence. The vessel belonged to the collection of the wealthy Florentine Giovanni Pietro Campana (1808–1880), who had already assembled one of the eight largest collections of ancient vases by the mid-19th century. However, his love of art brought him severe misfortune: to finance his passion, he, as bank director of the Monte di Pietà National Bank in Rome, secretly absconded with a very substantial amount of funds from the bank. His embezzlement was discovered and he was convicted in a sensational court case in 1858. The sentence was severe – his collection was confiscated and sold to France, England, Russia, and other countries. A few boxes of shards met a different fate. In his diaries, Ludwig Pollak recounted how Paul Hartwig and Friedrich Hauser apparently purchased them at the beginning of their career in Rome, conserved the shards, and resold them.

Paul Hartwig received other opportunities from the sale of another large collection as well, that of the brothers Alessandro (1824–1883) and Augusto (1829–1914) Castellani in Rome. Five fragments and groupings of fragments in Göttingen – all from the 1897 sales list – have recently been discovered to match shards in the inventories of the Villa Giulia Museum in Rome. The museum purchased the rest of the collection from Augusto’s son, Alfredo Castellani, in 1919. The best-preserved example of the links between the two collections is an eye cup in Göttingen with the rare depiction of a ram’s head between the large eyes (Fig. 4), which lends its name to this group of cups. The

Fig. 3a. Fragment of small Chalcidic black-figure Amphora, Göttingen H 17
Ca. 530 BC – Group of the Orvieto Hydria
Photo: Norbert Eschbach

Fig. 3b. Florence, Museo Archeologico Nazionale, Inv. 115096.
Photo: Norbert Eschbach



second half in the Villa Giulia Museum matches – fracture for fracture – and the traces of shellac would even indicate that the two pieces of the vessel had once been conserved and joined.

20 fragments of the collection belong to a red-figure bowl (Fig. 5a) that Paul Hartwig might have possessed after moving to Rome, since some of the scenes are depicted in a drawing he made as part of his work on ancient bowl masterpieces. They are from Alfred Bourguignon's (1865–1921) collection in Naples. Only two fragments had previously been connected with bowl fragments in the collection of ancient art at the University of Erlangen; they were also from Paul Hartwig (1907). The picture shows the complete Göttingen shard grouping together with the bowl base from Erlangen in the assumed position in the vessel when it had been intact. Hartwig's sketch seems to indicate that there may be other shards in a collection that have yet to be discovered. The pictures are closely related in terms of their topic: a young boy is pouring the contents of a jug back into a large mixing vessel. There is a second boy on the opposite side carrying a similar one with the symposium guests surrounding them, preparing themselves for a drunken procession in honour of the god Dionysus ('Komos'). The young boy in the inner picture is carrying a cup in his hand, the typical drinking vessel of the symposium, and a barbiton musical instrument in the other arm. The head is tilted backward and the mouth slightly agape. There is a surprisingly informative inscription, the gist of which can be translated as: "I'll make Komos to the music of the aulos."

The links between numerous fragments in the Göttingen collection and the inventories of other university collections, national and international museums and, in particular, shards belonging to

old collections from the 19th century, are naturally welcome news for conservators, since the inventory publications can often help the identification of further relationships. For example, work with Göttingen shards recently resulted in the reassembly of nearly an entire bowl – practically only the handle is missing (Fig. 6d).

The base of the bowl in Göttingen, from an early classical Epeleios painter (Figs. 6a-c; Hartwig, delivery 1897), shows an almost completely intact inner picture in which a plump naked young boy steps to the right and holds a wreath of leaves in his hair with his left hand. The remaining parts of the outer picture on the B-side, which are hardly visible, cannot be easily understood on their own. The odd posture of a figure on the ground is compelling enough to make one search for a 'missing link' in the uncommon motif. The depiction on the fragment from Göttingen only becomes clear once it is connected to the related fragments in Heidelberg, Amsterdam, Rome, and Flo-



Fig. 4. Fragments of attic black-figure bowl in Göttingen (K 376, above) and Rome, Museo di Villa Giulia Inv. 79523 (below) Photomontage · Photos: Stephan Eckardt / Norbert Eschbach

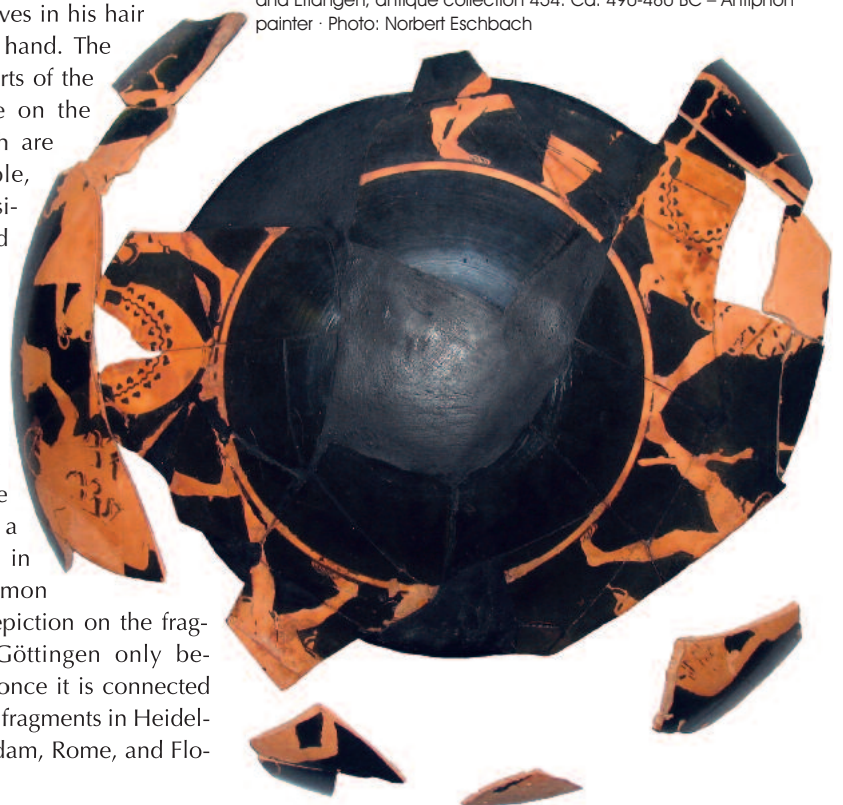


Fig. 5. Fragments of attic red-figure bowl in Göttingen (Hu 566.1; a-g) and Erlangen, antique collection 454. Ca. 490-480 BC – Antiphon painter · Photo: Norbert Eschbach



Figs 6a-c. Fragments of attic red-figure bowl, Göttingen R 87
Ca. 510-500 BC –
Epeleios painter
Photo: Stephan Eckardt

rence; the pictures here are also part of the drunken procession of symposium guests, where one of the young boys fell

intriguing opportunities. A good starting point would be an exhibition that presents the advances made in the restoration and treatment of the collection of Greek

pottery and in particular the links the Göttingen fragments have with museums across the globe. In fact, just such an exhibition is planned for 2013. ◀



backwards and propped himself on the ground using his arms.

If we take the fragments from the Göttingen collection and their global links and add the numerous corrections discovered on scattered fragments of Attic black- and red-figure pottery, a large project combining and evaluating all of our knowledge offers a number of


Fig. 6d. Göttingen R 87 together with fragments from Amsterdam, Allard Person · Museum; Heidelberg, Collection Of the Archaeological Institute; Florence, Museo Archeologico Nazionale; and Rome, Museo di Villa Giulia.
Photo: Norbert Eschbach

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Prof. Dr. Norbert Eschbach, born in 1954, studied archaeology at the Universities of Bochum and Mainz, at the latter of which he received his doctorate in 1982 on the topic of Panathenaic prize amphoras. From 1985 to 2002 he worked at the University of Giessen, first as research associate and then, after his habilitation in 1995, as a lecturer. Between the years of 1994-2004 and again in 2008 he led several digs on the Perge Acropolis in southern Turkey. Since 2002 he has been working at the University of Göttingen as well as on behalf of Corpus Vasorum Antiquorum on the Archaeological Institute's black- and red-figure pottery collection, as well as on two projects relating to pottery finds in Athens. In 2008 and 2009 he acted as chair of the Göttingen Archaeology Institute, and in 2010 he was named adjunct professor of the University of Giessen. He was the co-initiator and, since 2001, has been on the board of the Prometheus Image Archive. His research interests, apart from ancient Greek pottery, encompass Greek sculpture as well as cultural studies and fieldwork.

The Cast Collection of Antique Sculptures

The University of Göttingen's Archaeological Institute has a rich and diverse collection that has played a special role in the history of archaeology. The University itself was the first to offer archaeology as an academic programme. Christian Gottlob Heyne (1729–1812), a classical scholar and archaeologist, held his famous lecture on ancient Greek and Roman art during the summer term of 1767. The lecture was so well received that he continually repeated it over the next 40 years, attracting students from all across Europe. In 1767 Heyne also started collecting plaster casts of sculptures from ancient Greece and

Rome to provide his audience with a physical, three-dimensional view of the artworks he discussed. His successors continued to expand the collection. Today it includes more than 2,000 casts, making it one of the largest academic collections of its kind in the world. The collection is used intensively in both education and research, and is open to the public. An interactive survey of the collection has also been digitally created and is freely available online as the 'Virtual Museum of Antiquities – VIAMUS' (www.viamus.de).

The collection of plaster casts offers an unusually thorough overview of the history of Greek

and Roman sculptures from the period beginning around 700 BC up to the emergence of Christianity. Portrait art from this period, which has been a central research topic of Göttingen's archaeologists for decades, is one of the department's emphases. One of the unique advantages offered by plaster casts has been utilised with particular success in Göttingen: statues of Greek poets and philosophers that had previously only been available in scattered and incomplete Roman copies were reconstructed, offering a tangible and original-sized impression of the lost originals. The collection of plaster casts also serves as an ex-



The 'Bunte Götter' ('Colourful Gods') exhibition in 2011 featured hand-painted reconstructions of antique sculptures. Photo: Stephan Eckhardt



Photo: Stephan Eckardt

perimental laboratory to test out various reconstruction hypotheses.

Even the latest research project based on the collection utilises the plaster casts to help revive lost material and make it tangible once again: the original painting and gold-plating of a late-antique imperial portrait made from dark red porphyry was successfully restored using a plaster cast. Along the same lines, the internationally renowned travelling exhibition ‘Bunte Götter’ (‘Colourful Gods’), which was shown in the collection’s rooms in 2011, features vividly-coloured reconstructions of antique sculptures created by the Institute’s conservator and students.

Since plaster casts of antique sculptures represent only a single – though vital – aspect of archaeological studies, a parallel collection of original classical art was begun in 1839. Karl Otfried Müller (1797–1840), a famous classical scholar from Göttingen, purchased the first vases, clay figures and marble sculptures for the University of Göttingen on a trip to Italy and Greece. The vase collection in particular was greatly enriched in the second half of the nineteenth century thanks to a series of substantial purchases and to permanent loans by the National Museums in Berlin. Large inventories including shards, which are particularly useful in training ar-

chaeologists, as well as undamaged vessels were purchased. The systematic study of the Göttingen vase collection and its subsequent publication through the *Corpus Vasorum Antiquorum* project have continued to shed more light in recent years on how the fragments are intricately tied to collections around the world.

In addition to the objects purchased through normal art dealers, the Göttingen collection contains entire complexes from scheduled excavations. Berlin granted the institute a portion of the find from Heinrich Schliemann’s excavations in Troy in 1902. Similarly significant are Johannes Boehlau’s archaeological finds from Larissa in western Turkey, which are conserved at the Göttingen Archaeological Institute together with all related documentation and frequently consulted for international research projects. And one of the oldest and most intact collections of classical objects in Germany has been in Göttingen since 1979, thanks to a long-term loan from the House of Hanover. The Wallmoden Collection contains more than 50 Roman marble sculptures that the Graf von Wallmoden-Gimborn, a military general from Hanover, acquired in Rome around 1765.

The Archaeological Institute is home to the University’s extensive coin collection as well. It was also founded by Christian Gottlob Heyne in 1773 and with its approximately 40,000 coins and medals stemming from ancient, medieval and modern times is among the largest university-owned numismatic collections in Germany.

All these collections have been housed since 1912 in a seminar building erected specifically for this purpose. They are frequently consulted by students and scholars, and parts are also open to the public.

Daniel Graepler

The University Association

Members of the University, alumni, representatives from trade and industry as well as people from all parts of society have come together in the Göttingen Universitätsbund (University Association) to support 'their' University. In times in which the state is increasingly withdrawing from its responsibility to adequately fund its universities, private contributions are becoming ever more important. They help to improve conditions for research and teaching and thus strengthen the innovative potential of the University.

The University of Göttingen has a rich tradition and enjoys an excellent reputation worldwide. A broad spectrum of academic disciplines and many international study programmes attract students around the globe. Established in 1918 as a charitable entity, the primary aim of the Universitätsbund Göttingen e.V. is to support and enhance the University's academic strengths. Apart from financial aid for students and young researchers, funding extends to diverse scientific and cultural activities. The Universitätsbund places particular emphasis on promoting the dialogue between science and society, between University and public. Other areas of support include local conferences and lecture series, the University's research magazine and the Academic Orchestra. Recent projects contributed to the renovation of the Aula Building on the Wilhelmsplatz and of several lecture halls on the main campus.

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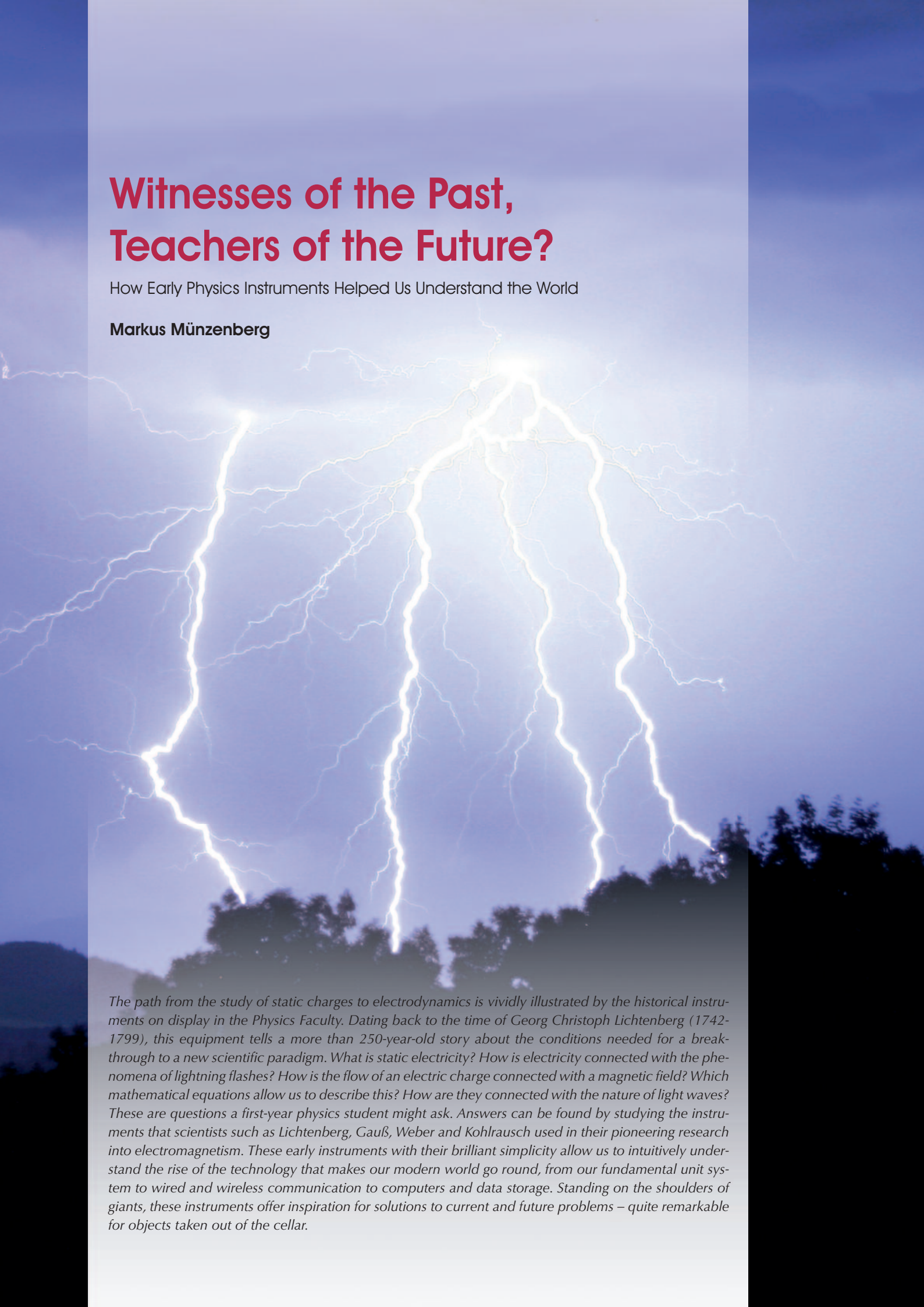


Electricity in the atmosphere has long been the subject of fascination. Both Benjamin Franklin and Georg Christoph Lichtenberg studied lightning in the 18th century.

Witnesses of the Past, Teachers of the Future?

How Early Physics Instruments Helped Us Understand the World

Markus Münzenberg



The path from the study of static charges to electrodynamics is vividly illustrated by the historical instruments on display in the Physics Faculty. Dating back to the time of Georg Christoph Lichtenberg (1742-1799), this equipment tells a more than 250-year-old story about the conditions needed for a breakthrough to a new scientific paradigm. What is static electricity? How is electricity connected with the phenomena of lightning flashes? How is the flow of an electric charge connected with a magnetic field? Which mathematical equations allow us to describe this? How are they connected with the nature of light waves? These are questions a first-year physics student might ask. Answers can be found by studying the instruments that scientists such as Lichtenberg, Gauß, Weber and Kohlrausch used in their pioneering research into electromagnetism. These early instruments with their brilliant simplicity allow us to intuitively understand the rise of the technology that makes our modern world go round, from our fundamental unit system to wired and wireless communication to computers and data storage. Standing on the shoulders of giants, these instruments offer inspiration for solutions to current and future problems – quite remarkable for objects taken out of the cellar.

Artistic impression of a neuron firing electric pulses for stimuli transmission in a neural network.



Galvani and Volta

When Luigi Galvani (1737–1798) experimented with electricity machines, frictional electrical machines and Leyden jars (early capacitors) at the medical school of Bologna, he started with a frog’s leg. Attempting to decipher the nature of life through his study of biology, he discovered that an electric discharge sent through the leg resulted in a prompt contraction of the muscles. Systematic investigations followed: by connecting a kite to the frog’s leg during a thunderstorm, he found he could exploit the electricity in the air to initiate the same muscular motion. When the physicist Alessan-

dro Volta (1745–1827) learned of Galvani’s experiment, however, he disputed the interpretation of the results. Volta claimed that it was not the frog’s life force that could be seen, but instead a reaction of the muscles to the electric charge. Subsequent experiments of his own allowed Volta to develop the voltaic pile, the first battery, and the *electrophorus*, a high voltage electrostatic generator comprised of a plate of resin.

Benjamin Franklin and the First Experiments on Static Electricity

In the 18th century public interest in science greatly increased following investment in education

and research. The aristocratic high society in particular was fascinated by ‘spectacular’ experiments – things like lightning discharges in gas tubes and the sparks of frictional electricity generated by rubbing machines. ‘Electrical soirees’ were staged by the intellectual elite, and for the first time science became a matter of public interest. The young book printer Benjamin Franklin (1706–1790) was one of those who were fascinated by electricity, in particular the phenomena of lightning. It was, however, a dangerous field of research: a single lightning flash discharges millions of volts and can be deadly. As a representative of the British colonies and later of the independent United States, Franklin visited Europe on several occasions, and thanks to his friendship with the prominent professor of Biblical and Oriental studies Johann David Michaelis (1717–1791), one of those visits included the young University of Göttingen. His stay was documented in 1766. Among other activities, he gathered the professors of the Göttingen Academy of Sciences together at his house, where a vivid exchange was fostered and fascinating experiments with electricity machines were carried out. In subsequent letters he offered his best wishes for the young faculties’ future.

Frictional electrical machine with a rotating glass plate from Lichtenberg’s laboratory. The separated charge is rotated and picked up by a needles at the spherical capacitor. The charged status is indicated by the vertical position of the straw pointer. Photos: Manfred Mahn (right), Frank Stefan Kimmel (left)



Franklin and Lichtenberg

It is not clear if the young Georg Christoph Lichtenberg, who was a student in Göttingen in 1766, met Franklin or not. What is clear is that he was inspired by Franklin's research as his own work demonstrated: electricity was his primary focus, he regularly took students on excursions to the hills around Göttingen to conduct experiments with a kite, and he installed the first successful lightning rod in Germany on the cabin in his yard. As the first professor of experimental physics, he began giving the University's physics lectures in 1768, succeeding naturalist Johann Christian Erxleben.

In the spirit of the Enlightenment, every theorem had to have its experimental evidence. The paying students in his private lecture rooms were amazed by his theatrical demonstrations; he particularly loved seeing the surprise on their faces, as he recounted in one of his letters. His experiments, which included suspending himself from his set of Magdeburg hemispheres to demonstrate the power of a vacuum and igniting hydrogen-filled balloons to produce a thunderous bang, were always met with enthusiastic ovations.

His edited versions of Erxleben's *Anfangsgründe der Naturlehre* also became best sellers. The



chapter on electricity in particular is a fascinating glimpse into the knowledge of the day. The French chemist Charles Du Fay discovered two different types of electricity through the application of friction, which he named after the materials he found them in, 'électricité vitrée et résinée', vitreous and resinous electricity. Lichtenberg, however, demonstrated in his lectures why this theory was flawed. He showed that the nature of a charge can be altered by the second material used for the rubbing, or by modification of the surfaces (smooth and rough). Franklin's theory of electricity then went one step beyond Du Fay's. He postulated that there is some kind of electric matter – the same



for all materials – which is preserved and transferred from one object to the other in the rubbing process.

Lichtenberg Figures

The finding that eventually solved this controversy was wholly accidental. To study high-voltage electrostatic flashes more than 70cm long, Lichtenberg experimented with an electrophorus two meters in diameter. As the dust settled down at the discharge area on the insulating electrophorus surface, he noticed the appearance of well-defined patterns. In a letter he described the patterns' beautiful elegance and fractal shape. Later he confirmed in systematic investigations on a series of mate-

(left) Lichtenberg's larger electrophorus from ca. 1780 (~30 cm diameter), with cat's fur and tinfoil-coated wooden plate and (right) a smaller version with Lichtenberg figure for the positive charge: sun-like dust pattern on the resin cake.

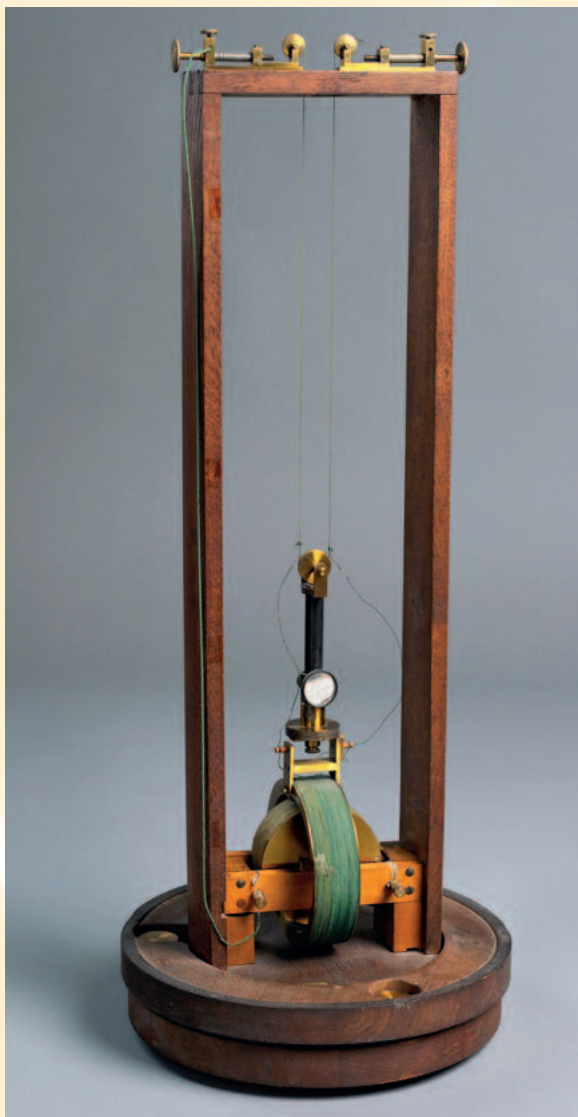
Photos: Frank Stefan Kimmel



(left) Reproducing the Lichtenberg figure with Lichtenberg's historical apparatus: Leyden jar, small electrophorus and powder caster.

(right) Measurement of an electric charge: Bennet's gold-leaf electroscope in action.

Photos: Manfred Mahn (left), Frank Stefan Kimmel (right)



Instrument from Weber's laboratory to investigate electromagnetism: the electro-dynamometer from 1841 with mirror and torsion wires.
Photo:
Frank Stefan Kimmel

rials that this discovery allowed him to modify Franklin's theory of electric charge. Exactly two kinds of patters turned up in the dust, which meant that two kinds of charges exist – positive and negative. He determined that positive charges ('+E') correspond to the radiating, sun-like Lichtenberg figure, whereas negative charges ('-E') are represented by a circular, branchless structure.

Another instrument to measure electric charges are so called gold-leaf electroscopes. These feature two parallel leaves that naturally have the same sign and therefore repel each other when a charge is present. As the leaves are only 1/1000 of a millimetre thick, it is an extremely sensitive instru-

ment capable of detecting very low quantities of electricity.

Alessandro Volta's Visit to Göttingen

Exchange between scientists in those days happened not only through letters and publications, but also visits. One gets a vivid impression of the research being undertaken at Lichtenberg's laboratory by reading his letters recounting Volta's visit to Göttingen in 1784. The two debated intensively and performed numerous experiments together: they released balloons out of the window to measure atmospheric electricity, for example, and generated electric discharges to produce what they called *Sonnenschlagen* (sun strikes), or positively-charged Lichtenberg figures.

The key to making new discoveries was careful experimentation as well as precise instrumentation. While most of Lichtenberg's instruments came from London and were crafted by renowned instrument makers of that time, the next generation of researchers provided the impetus for the establishment of instrument production in Göttingen itself. One highly sensitive and important instrument was developed by French physicist Charles-Augustin de Coulomb and used to derive his namesake electrostatic law in 1785. The Coulomb torsion balance allows the quantitative measuring of attractive and repulsive forces between charges using a trick of friction-free measurement. The basic design, a combination of torsion wires and mirrors, continued to be used in all sensitive instruments until the invention of electric signal amplification and digitisation, and was a crucial device in the ongoing quest for a unified theory of electromagnetism.

Currents and Magnetic Fields: Oersted's Epic Discovery

Even though many researchers had the feeling that the phenome-

na of static electricity and magnetism must be somehow connected, their experiments to demonstrate this had not been successful. This all changed in 1820, when the Danish physicist Hans Christian Oersted connected a wire to a voltaic pile battery and put a compass next to it. He noticed that when it was carrying a charge, this conducting wire exerted the same kind of pull on the magnetic needle as the earth's natural magnetism. This groundbreaking discovery spread fast all over Europe. In Paris, François Arago, Jean-Baptiste Biot, Félix Savart and André-Marie Ampère took an immediate interest in this exciting phenomenon. It quickly became one of the central research areas of the field and soon the first quantitative laws of the attractive forces between wires were determined and proposed.

Weber und Gauß

In Göttingen at that time Carl Friedrich Gauß (1777–1855), animated by Wilhelm von Humboldt, began to study the phenomena of the earth's magnetic field. Together with his younger colleague Wilhelm Weber (1804–1891), Gauß constructed a sensitive torsion wire base magnetometer that allowed them to study daily changes in the magnetic field with great precision. The outcome was a magnetic field map of the earth. The 'Göttingen Magnetic Society' was one of the first international scientific collaborations, including up to 50 stations on different continents. A particular milestone was the use of special configurations to relate the magnetic field to an absolute unit system, the CGS (centimetre-gram-second) system proposed by Gauß in 1832, the predecessor to the international MKS (metre-kilogram-second) used today. It allowed electric and magnetic fields to be defined and connected them to three basic units in a quite elegant way.

A series of instruments developed by Weber are found in the University's collection. With the simplest instrument for measuring currents, the magnetic field of a single wound magnetic coil could be measured by the deviation of the magnetic needle in the middle. A much more complex but very precise and robust instrument is Weber's electro-dynamometer. Thanks to its precision it found distribution all over Europe. Again it is constructed by a torsion wire for the sensitive detection of even the smallest forces. Featuring one moveable and one fixed coil, when a current flows through both coils, the dipolar magnetic field of each exerts a torque on the other that can be determined. In later years galvanometers replaced the electro-dynamometer as the instrument of choice. They are of similar construction, except that they contain one permanent magnet.

Gauß-Weber's First Electromagnetic Telegraph

These same instruments were probably used for experiments on the first remote data transmission via electromagnetic principles. This first telegraph was constructed by Gauß and Weber in 1833; a double wire approximately 1000 meters long was strung from Weber's physics institute, across the tower of the St. Johanniskirche, to the Gauß observatory outside the town walls. An inductive current pulse was then sent encoded in binary numbers and detected at a receiver consisting of a coil, large magnetic needle and sensitive torsion-wire mounted mirror. Signal deviations could be observed via an optical telescope. The company Siemens and Halske (which later became Siemens) introduced the index telegraph in Germany and the first official telegram was sent in 1844 with the Morse telegraph in the United States. Telegraphy turned out to be, together with electrochemistry, the widest

spread application of the new field of electrical engineering in the 19th century.

Weber and Maxwell's Theory on Electromagnetism

While in Paris André-Marie Ampère described the force between two conductors with a current 'I' as

$$F = k \frac{I_1 I_2}{r^2} ds_1 ds_2$$

where 'r' is the distance between the conductors, in his fundamental law of electrodynamics Weber identified the charges 'Q' moving in the conductor and combined it with Coulomb's electrostatic law

$$F = k \frac{Q_1 Q_2}{r^2} \left(1 - \frac{1}{c^2} \left(\frac{dr}{dt} \right)^2 + \frac{2r}{c^2} \frac{d^2 r}{dt^2} \right)$$

It was similar to a potential ansatz that mathematician Franz Neumann derived at around the same time which helped shape the understanding of electrodynamics in following years. Above all, precision experiments were needed to determine the constants. Together with his assistant Rudolf Kohlrausch (1809–1858), Weber studied a specified amount of charge on a sphere and the amount of electrostatic charge as measured by a Coulomb torsion balance,

and compared it to the effect of the discharge current by a needle galvanometer. This allowed him to determine the ratio between the electrostatic charge and the electromagnetic charge, which was given as 3.1074 108 m/s. Most interesting was that this factor, having the unit of a velocity, was very close to the value of the velocity of light as determined a few years earlier by Hippolyte Fizeau, 3.15 108 m/s. Even though Weber had a feeling about the importance of this experiment, he could not correlate the ratio with the velocity of light. He assumed there was movement of both positive and negative charges – a double current – and consequently the result deviated by a factor of two. Gustav Robert Kirchhoff made the connection a few years later based on Weber's findings, and it was soon verified by experiments.

Naturally these experiments drove the quest for a unified theory further. Weber hoped that his assistant Georg Bernhard Riemann (1826–1866) would finish his work on the mathematical unification of optics and electricity. Riemann eventually became the next in the line of influential mathematics professors at Göttingen

The Gauß-Weber telegraph. Photo: Frank Stefan Kimmel



that included Gauß and Peter Gustav Dirichlet, although his ansatz using a retarded potential to account for the propagation nature of electrodynamics remained unfinished due to his early death. The stroke of genius to unify electromagnetism ended up coming from the physicist James Clerk Maxwell (1831–1879). His work on electromagnetism was also based on the work of another scientific giant of the day, fellow Briton Michael Faraday (1791–1867). Faraday's experiments with polarised light revealed a second connection between light and magnetic fields and led to the development of the first concepts of electric and magnetic field lines. With the help of mechanical machines to illustrate the complex curls and displacements of the interacting fields, Maxwell filled these ideas into a mathematical framework and revealed that the nature of the velocity of light was in fact related to the magnetic and dielectric constants of free space. This was the foundation of the theory of electromagnetic waves, and closed

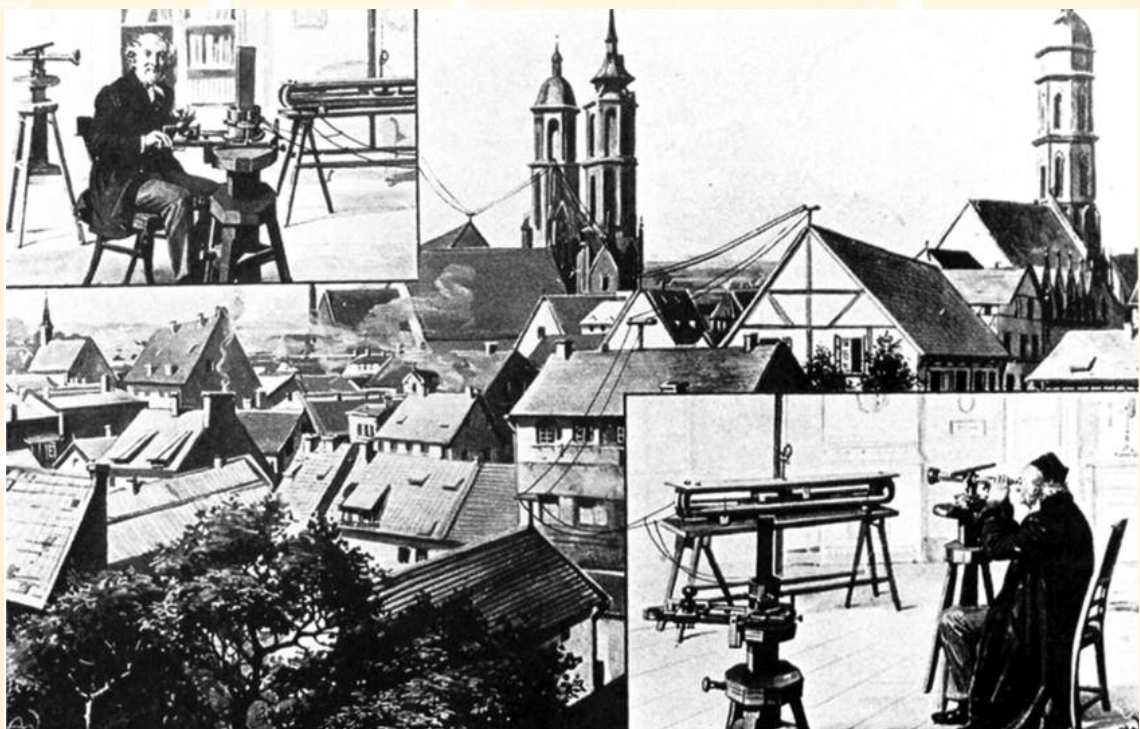
the first chapter on macroscopic understanding. Remnants of Weber's theory can be found in his idea of an oscillating trajectory of charges within a certain small sphere. These ideas were picked up by French physicist Paul Langevin in his 1906 model of paramagnetism, where he suggested that orbits of the microscopic current result in small magnetic moments of the atom. Ten years later, the atomic model was proposed by Niels Bohr in Denmark.

The Development of Microscopic Theories

This illustrates the general progression of how new ideas are born, are refined and eventually lead to a new scientific paradigm. Weber's precision experiments, the visionary suggestions by Faraday proposing a connection between light and electromagnetic fields, the mathematical contributions and finally Maxwell's brilliantly simple unifying theory of electromagnetism paved the way for a whole new area of research. Subsequent experiments by Heinrich Hertz verified the existence

of electromagnetic waves. Experiments with cathode rays and vacuum tubes led to the discovery of the electron and X-rays. Physics also underwent a 'mathematification': things that had previously been seen as specialised tools of mathematics such as vectors, matrices and tensors entered physics and were used to describe phenomena like light polarisation and crystal symmetries. This can be seen in the work of Göttingen physicist Woldemar Voigt (1820–1919), whose student Paul Drude (1863–1906) developed the first microscopic theories of electrons flowing in a conductor.

The quest for understanding the atomic level was the main concern of the next few decades, and again necessitated parallel advances in mathematics. Names like Born, Heisenberg, Oppenheimer and Pauli, and Klein and Hilbert, thanks to their work in quantum mechanics, helped make Göttingen one of the international centres of mathematics. The use of non-commuting matrices was key to describing the mechanics of the microscopic quan-



Gauß and Weber strung the first electromagnetic telegraph line over the roofs of Göttingen in 1833, from the physics institute to the observatory.

tum world and laid the foundation to explain the nature of the electronic state of atoms and matter on sub-nanometer, atomic length scales. Unfortunately, though, this intense and exciting period ended abruptly with the rise of National Socialism in 1933.

Quantum mechanics has allowed modern society to develop things like mobile computing and other solid-state semiconductor devices, while electromagnetism is the foundation of modern mobile communication. However even as our technology becomes ever more complex – nanoscale devices for future energy-efficient applications and novel superconducting materials, for instance – our knowledge of many things remains limited. One very illustrative example may be Galvani's mystery of animal electricity. How are the electric responses of single neurons, the building blocks of higher integration, connected to the full functions of the brain?

250 years after Galvani, Volta and Lichtenberg, we are still lacking a thorough understanding. We will see in what respect the 'witnesses

of the past' will stimulate students and scientists to finally solve these unanswered questions on the origins of life itself. ◀



Markus Münzenberg, born in 1971, received his Ph.D. from Göttingen University in 2000 on X-ray magnetic circular dichroism. He performed his post-doctoral research at the Massachusetts Institute of Technology in Cambridge from 2001 to 2002 on spin transport in ferromagnetic tunneling magnetoresistance (TMR), and led a femtosecond magnetization dynamics group at Göttingen University as a junior faculty member from 2002 to 2008. Currently he is professor of experimental physics and leader of a research group at the First Physics Institute as well as curator of the Collection of Historical Physics Instruments. His main interests are spin-transport and dynamics – and sharing the wonder of historical physics instruments with students and scientists alike.

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The Collection of Historical Physics Instruments

The Collection of Historical Physics Instruments in the Physics Faculty merges instruments used for research and teaching in the 250-year-old tradition of physics at the University of Göttingen. Its attraction lies in the famous names that used them and the pioneering findings with which they were associated. Originally used in lectures, demonstrations and experiments, their time-worn surfaces crafted from brass, glass, leather and wood open a window into the illustrious history of physics at the University. The starting point of the collection were the instruments Georg Christoph Lichtenberg bought privately to use in his research, including objects designed for studying mechanics, hydrostatics, dynamics, optics, electricity and magnetism.

Most expensive – equivalent to a year's salary for Lichtenberg – was a vacuum pump crafted by Naire and Blunt, London, which reached a base pressure of 0.4 Torr, and was used in conjunction with Magdeburg hemispheres and a metal bell inside a bell jar to illustrate the effects of the absence of air. The university acquired all of these instruments from Lichtenberg in 1789. There is also a complete collection of electrometers, magnetometers and inductors. The Gauß-Weber telegraph, rebuilt by Wilhelm Weber for the 1873 International Exhibition in Vienna, is a key piece in the collection. Another important instrument is Carl Friedrich Gauß's Vize-Heliotrop, a sextant with an additional mirror for triangulation over long distances, which used to be

depicted on the back of the German 10 Mark note. The modern part of the collection hosts a collection of spectrometers, vacuum glass tubes to study cathode rays and X-rays. The oldest commercial X-ray tube from the company Siemens and Halske, sold only two months after Röntgen's groundbreaking discovery, is also part of this collection. Over the last few years a museum displaying a number of the instruments has been set up at the entrance to the new physics lecture halls. In addition, parts of two other important historical collections, the instrument collections of the Astrophysics and Geophysics Institutes, are on display. Together these three collections offer a comprehensive insight into the history of physics at the University of Göttingen.

The Value of Demonstration *Robert Wichard Pohl's Lecture Collection*

The Göttingen Lecture Collection – an assemblage of physics experiments and historical records that form a part of the Collection of Historical Physics Instruments – was the first of its kind and thus has exceptional historical value. The idea behind these collected works was to bring students closer to the laws of nature by having them visibly experience experiments – an educational approach highly valued these days too, and not only by teachers of physics. If you take a peek behind the lecture halls of the Göttingen Physics Department's new building – outfitted with state-of-the-art technology – you will find the rooms where today's experiments are set up in preparation for lectures. Here, four technicians are hard at work, continuing in the tradition founded at the beginning of the 20th century by the physics professor Robert Wichard Pohl (1884–1976),

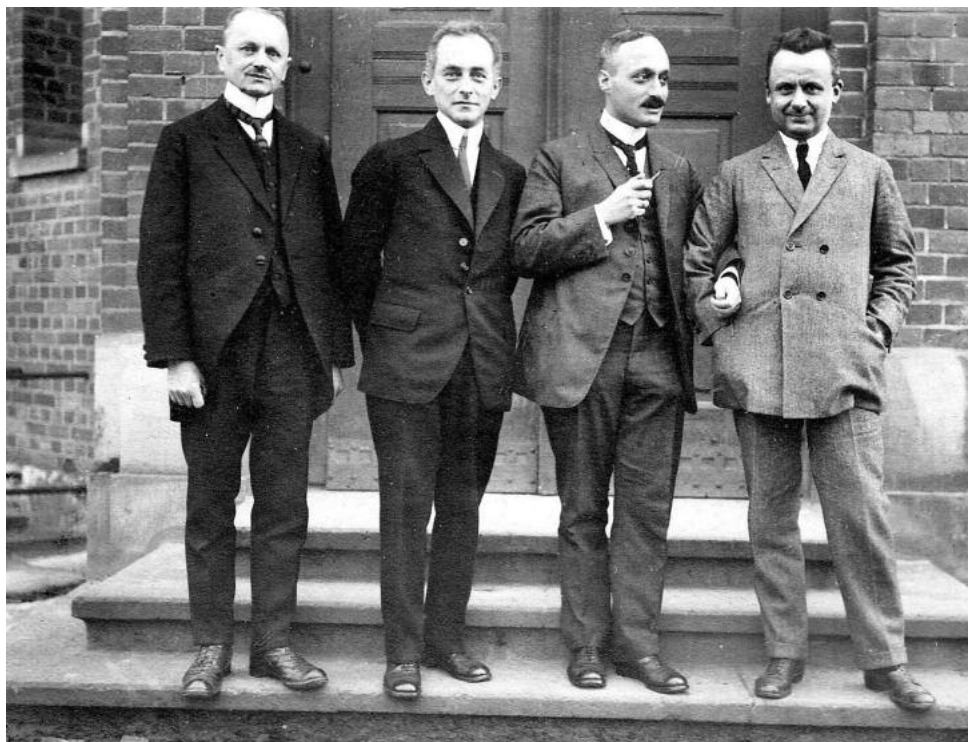
which he disseminated in textbooks that still today rank as classics in the field of physics.

From 1919 until his retirement in 1952, Robert Wichard Pohl was Director of the First Institute of Physics at the University of Göttingen. As a schoolboy in Hamburg, the young Pohl bought and constructed the first equipment for his experimental displays. He spent the huge sum of 100 Marks for an inductor that he could deploy to demonstrate electromagnetic current. In 1912, he wrote to his mother: "I wish I had invested all the money I made in my lifetime so usefully as I did for my inductor. Even today, all my fellow physicists envy me for its handy, convenient shape coupled with high performance functionality." During his studies in Heidelberg and Berlin and his time as a research fellow in Berlin from 1905 to 1914, Pohl continued to ex-

pand his experimental equipment collection. While serving in the war as a captain in the technical division of the Radio Operators Corps, he even traded food as payment to have equipment fabricated in Berlin for his future professorship in Göttingen. On this subject, Pohl wrote this to his sister in 1918: "I think I wrote you before that I had taken items of food I had (...) and used them to have Ruben's mechanic construct physics instruments for me for Göttingen."

In 1912, Pohl wrote his post-doctoral thesis about the physics of X-rays, discovering early on as a research assistant in Berlin the positive effect his experiment lectures had on students and colleagues alike. Once in Göttingen, he continued in this successful vein. Here, he was able to rely on a large number of technical devices that he brought from Berlin to Göttingen "in twenty-some boxes". As he reported in 1919: "...all the business of setting up the institute is very time consuming. But the success makes my efforts worthwhile – today I had around 230 people in attendance while Madelung [Erwin Madelung, 1881–1972, solid-state physicist and Pohl's future brother-in-law] had 110; the people are palpably interested. I'm having great fun with this and do not regret taking this interim semester for courses. For 80% of the experiments I use my own equipment, I do everything right away properly, write down the dispositions, make drawings of the setup plans and organise my stuff in the cabinets in my room (...). I'm very happy about my work and am achieving what I wanted to achieve right from the start – to have a post as a lecturer, whose classes students

From left to right:
Max Reich, Max Born,
James Franck and
Robert Wichard Pohl,
together in Göttingen
in 1923.
Photo: GFHund



take because they can get something they can't get from books."

It was not only his time, but also portions of his income that he used to build new setups and experiments – investments he never regretted: "I'm putting at least 2,000 Marks from my lecturer's salary into new equipment. I didn't appreciate what a productive capital investment I have in my own collection until I got to Göttingen. The students see almost only new things (for example the measurement of the speed of light, which he described in [Einführung in die Optik, Springer 1940, p. 105]) all in all, lecturing has certainly turned out to be a job from which I derive pleasure in a way I never anticipated."

With his experimental demonstrations and his fundamental textbooks on physics, Robert Wichard

Pohl made a vastly important contribution to the teaching of natural sciences. Many of his experiments entered into physics courses all over the world, such as the impressive Pohl's interference experiment using a thin mica plate named after him [Einführung in die Optik, 2nd/3rd Edition, Springer 1941, p. 69]. Since 1979, the German Physics Society has annually awarded the Robert Wichard Pohl Prize for valuable contributions to physics education and cross-disciplinary work in experimental physics. Pohl also received the highest recognition from his long-time (study) friend and colleague, the Nobel Prize winner James Franck (1882–1964). In 1960, Franck wrote from the USA: "I should have written you a long time ago to give you my warm appreciation for sending me the 14th

edition of the first volume of Your Physics. I say 'Your Physics', meaning your method of teaching physics. How important and necessary it is, I did not actually appreciate until I was in the USA, where I observed with extreme displeasure how miserable lecture experiments impede young students from gaining an understanding of physics."

To this day, the Göttingen collection of his equipment and lecture manuscripts is still a source of inspiration for physics teachers everywhere. Meanwhile, thanks to the efforts of his son Robert Otto Pohl, Emeritus Physics Professor at Cornell University (USA), many of Pohl's experiment demonstrations have been recorded and preserved in video form.

Robert Otto Pohl/red.



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The Collection of Mathematical Models and Instruments Perspectives for Tomorrow

The collection in the Mathematics Institute is comprised of models, sculptures and machines, some of which are more than 200 years old. In 1881, the Collection of Mathematical Models and Instruments was initiated by Hermann Amandus Schwarz (1843–1921), who modernized the existing material. As a special feature, a room was established for students to produce drawings related to the collection.

Beginning in 1886, Felix Klein (1849–1925) was responsible for the collection. He promoted elements of visualisation for teaching mathematics in schools and at the university, and he had the vision to share mathematics with the wider public. The connection to research was Klein's 'Erlanger Programme', which he had published as a manifesto – a work that has shaped the way we think about geometry today. Apart from these conceptual milestones, Klein was a talented manager who organised funding for the collection.

Geometric objects constitute the major part of the Göttingen collection (and other places following its example). The collection's influence on teaching has found its way into various textbooks – with Geometry and Imag-

ination by Hilbert and Cohn-Vossen being one of the prominent examples. From 1890 to 1911, more than 20 doctoral theses were completed under the supervision of Klein at Göttingen, and many relate to models of the collection. The active participation of students in the creation of visualisations and in experiments is documented.

The online documentation of models and their well-documented attraction for historical studies underline the landmark nature of the collection. It symbolizes an era in the history of mathematics where Göttingen played a central role. Taking up the founders' spirit of regular modernisation – and noting the development of mathematics – suggests the need for supplementing the collection by novel media and methods.

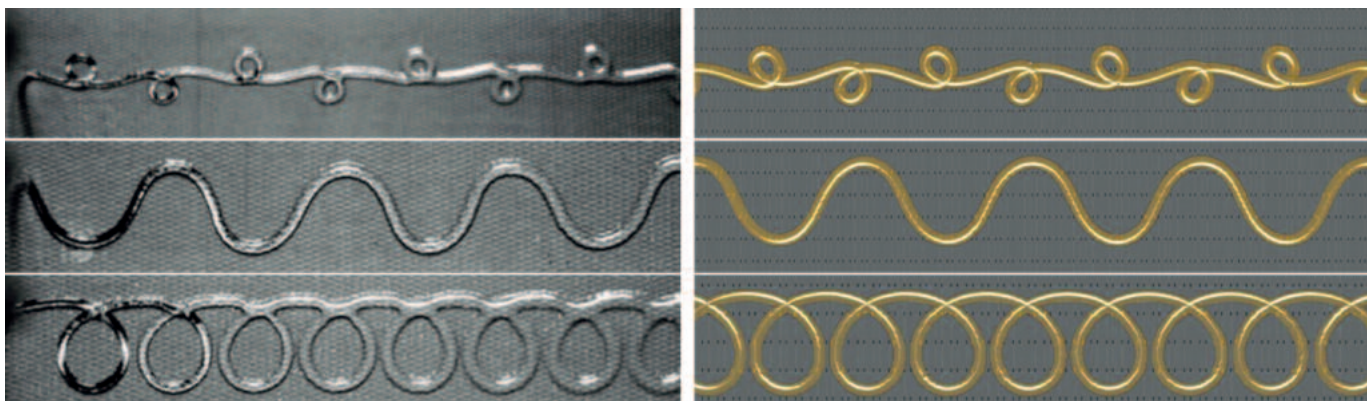
Contemporary mathematical research and teaching at Göttingen ties in with the main topics of the collection – visualisation and experimentation. While various visualisations can nowadays be carried out at comparably low cost with the help of sophisticated software, accurate simulations of mathematical and physical phenomena still constitute a major challenge.

Visualisation and simulation help researchers to test hypotheses, to develop intuition for solving complex problems, and to extract important structures that govern physical phenomena. For example, Prof. Dr. Max Wardetzky of the Institute for Numerical and Applied Mathematics develops inexpensive yet physically accurate simulations of deformable elastic objects by preserving the underlying geometry that governs the physics. This allows for a deeper understanding of the fascinating nonlinear behaviour of deformable bodies and for an involvement of students with different backgrounds (Fig.1).

Using experiments to get a better feel for new results and suitable definitions entered in many areas of mathematics. It is relatively recent that this shift in the practice has become a topic of study itself. Prof. Dr. Russell Luke, also of the Institute for Numerical and Applied Mathematics, develops methods for mathematical experimenting and is co-author of *Experimental Mathematics in Action* (A. K. Peters, 2007).

Using simple geometric visualization tools Luke and colleagues search complicated iterations for patterns and counterexamples to

Fig. 1. A thin thread of viscous fluid poured onto a moving belt creates a dazzling array of intricate patterns. Simulations based on "Discrete Viscous Threads" (ACM Transaction on Graphics 29:4, 116:1-116:10, 2010.) reproduce this rich and complex behaviour. Translucent thread: experiment [Chiu-Webster and Lister 2006]; gold thread: simulation. Photo: Max Wardetzky



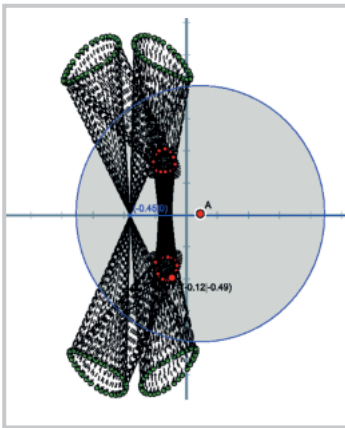


Fig. 2. Iterates of the Douglas-Rachford Algorithm – a standard method of image recovery in diffraction.

prove or disprove claims about their behaviour. Illustrated above (Fig. 2) are iterates of the well-

known Douglas-Rachford Algorithm – a standard method of image recovery in diffraction imaging. The proof of divergence of these iterates was first established in 2010 and extends to some of the settings for diffraction imaging, however the most common practical settings remain unresolved.

Sometimes it is still desirable to use this digital information to produce 'live' models. Prof. Dr. Laurent Bartholdi of the Mathematical Institute works out long-term research projects for young students which also start with simulations and visualisations. For a project aiming at understanding certain dynamical systems on surfaces, a

3D-printer produces models on which these dynamics can be depicted and better understood. Their production requires careful mathematical considerations and opens up new perspectives on creating models for active areas of research.

Mathematical experiments, digitally visualised simulations, and the production of new models extend the main ideas of the collection in the Bachelor and Master's programmes in mathematics at Göttingen today.

*Laurent Bartholdi,
Stefan Halverscheid,
Russel Luke,
Max Wardetzky*



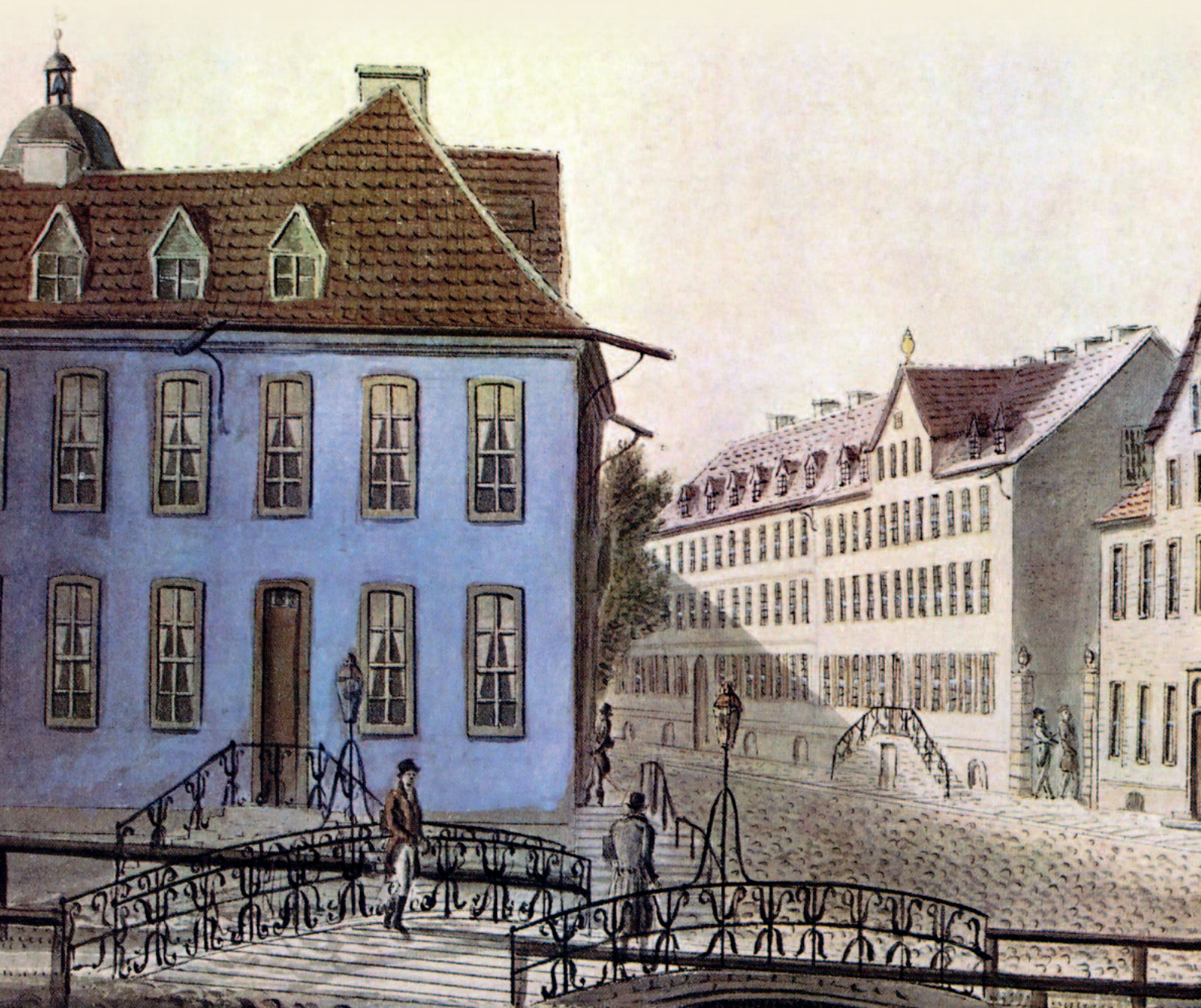
Photo: Frank Stefan Kimmel

The Natural World through Blumenbach's Eyes

Digitising the Legacy of Göttingen's Greatest Collector

Nicolaas Rupke and Wolfgang Böker

The Göttingen Professor of Medicine and Natural History, Johann Friedrich Blumenbach (1752–1840), was one of the leading exponents of the revolutionary change taking place at the turn of the 18th to the 19th century in the geobiological conception of the natural world. Since January 2010, the vast body of his work, comprising more than a thousand publications, is the subject of a project entitled 'Johann Friedrich Blumenbach – online'. This long-term project is coordinated by the Union of German Academies of Sciences and Humanities, and located at the Göttingen Academy of Sciences and Humanities (www.blumenbach-online.de). A significant part of the project is the documentation of the scientific specimens that Blumenbach collected for the Göttingen 'Academic Museum'.



Natural History Collections – Then

Over the past few decades, historians of science have increasingly paid attention to scientific collections, in particular collections of natural history. Large multi-author volumes and specialized monographs that deal with a variety of specific collections as well as with the architecture of the buildings in which these were stored, displayed and worked on have been published. University museums, provincial museums, national museums, colonial museums and

more have been and are being studied in detail, all part of the recognition that, in order to understand the development of the natural sciences, we need to pay attention to their material conditions.

There are many good reasons to focus interest on such collections. The collecting of natural artefacts and the establishment of natural history museums were critical elements in the development of biomedical and geological sciences. Towards the end of the 18th century, John Hunter

(1728–1793) in London and, somewhat later, Georges Cuvier (1769–1832) in Paris, founded famous museum collections of comparative anatomy. The discipline of palaeontology, and vertebrate palaeontology in particular, evolved within the context of the medical museums, when doctors and surgeons started recognising that many fossils belong to species of animals that no longer exist today.

The importance of these collections was indicated by the fact that they were housed in impres-



The Natural History Museum in London opened in 1881. The Romanesque edifice represents an institutional and architectural zenith in the development of Natural History Museums.

sive buildings, some true cathedrals of science. At Oxford University, for example, the Museum of Natural History, completed in 1860, is renowned for its Gothic Revival architecture. At Harvard, the Museum of Comparative Zoology, founded in 1859, remains a landmark building on campus to

tific truth mission that was connected to the collections of natural history objects it contained. These and many other museums of natural history became centres of professional teaching, research and public education, and to this day contribute to the cultural identity of the cities, and the uni-

Handbuch der Naturgeschichte (A Manual of the Elements of Natural History). He proposed that geological history be subdivided into different, successive periods, based on fossils and the degree of their similarity with living species. Thus, Blumenbach became one of the leading exponents of the revolutionary change of the geobiological conception of the world that took place at the turn of the 19th century.



Johann Friedrich Blumenbach. Portrait of Ernst Ludwig Riepenhausen, copperplate engraving, ca. 1800.



this day. The American Museum of Natural History, which opened in 1877, was in its original form a marvel of Victorian Gothic, while in London the Natural History Museum, completed in 1881, is still one of the grandest edifices to adorn the capital city. Its unequalled Romanesque architecture gave expression to the scien-

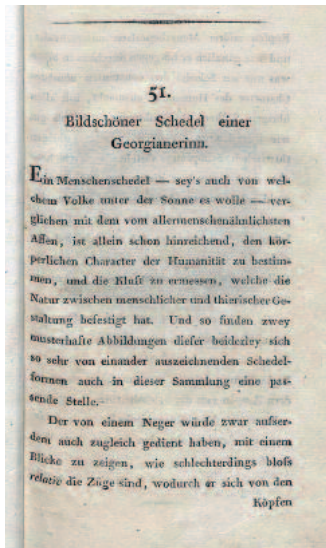
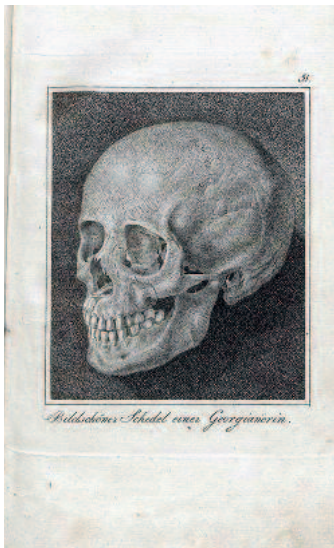
versities with which they are connected.

Göttingen's role in the early phase of this development was not inconsequential. As early as 1773, the city was home to an 'Academic Museum' to which the indefatigable collector Johann Friedrich Blumenbach (1752–1840) significantly contributed. As early as 1777, Blumenbach commenced a series of lectures on comparative anatomy. This was the first of its kind at a German university; and the series was subsequently published as the *Handbuch der vergleichenden Anatomie (A Manual of Comparative Anatomy)* (1805 and later editions). The comparative approach allowed exact identification of many fossils and yielded evidence for the phenomenon of the extinction of species. Blumenbach discussed this and similar phenomena both in his *Beyträge zur Naturgeschichte (Contributions to Natural History)* (1790 and subsequent editions) and in the later editions of his

Natural History Collections – Now

Today, many historical collections are gaining new importance as the result of modern techniques to examine old objects. Prominent among these are X-ray analysis, computerised axial tomography (CAT), magnetic resonance imaging (MRI) and also DNA testing. CAT scans and in particular MRI techniques have the great advantage that the original objects are not damaged and that soft tissues can be examined inside as well as outside. This has proved of enormous value in studying mummies, for example, which no longer need to be unwrapped or otherwise taken apart. A remarkable instance of the study of an historical soft-tissue object took place in Göttingen in 1998, when at the Max Planck Institute for Biophysical Chemistry the brain of the famous mathematician Carl Friedrich Gauss (1777–1855) was 'dissected' by means of MRI and reconstructed in digital form. Gauss's brain is part of a collection of brains of 'great minds', put together by Blumenbach's successor, the physiology professor Rudolf Wagner (1805–1864), who was a leading expert in brain morphology and keen to prove, against the rising monistic materialism of his day, that there are no scientific grounds to deny the existence of the human soul.

Moreover, the digital age has opened up new ways of making collections relevant by providing



electronic copies and making them widely accessible and useful. In Göttingen, the long-term project 'Johann Friedrich Blumenbach – online' is aimed at creating a virtual link between Blumenbach's writings and the specimens belonging to Blumenbach's natural history collections. In some of his works, particularly his *Handbuch der Naturgeschichte* (*Manual of the Elements of Natural History*), but equally the *Abbildungen naturhistorischer Gegenstände* (*Illustrations of Objects of Natural History*), Blumenbach explicitly refers to individual items, some of which are type specimens for the first descriptions of different fossils and living organisms. In other cases, implicit references are found to items in the collection. Many of these specimens – albeit widely dispersed – today still exist in Göttingen collections. One objective of the documentation of the Blumenbach specimens is to produce a virtual reconstruction of the original Academic Museum.

Global Collecting Instead of Travelling

Blumenbach's work in natural history had a global dimension. He examined mammoth bones from Ohio and Siberia (see article by Mike Reich and Alexander Gehler,

this volume), the duck-billed platypus, discovered in Australia, as well as animals and plants from Africa. Yet Blumenbach never visited these faraway places himself. Indeed, the travels he did undertake, namely to Switzerland (April–October 1783) and England (December 1791–January 1792), were hardly journeys of exploration. His main objectives were to get to know the scientific institutions of those countries personally and meet their leading representatives. Blumenbach's medium for exploring the world was not travel but collecting. By systematically expanding his research collection, Blumenbach was able to gain a global impression of the natural world.

This perception is corroborated by the perusal of Blumenbach's correspondence. There was hardly a letter that Blumenbach wrote in which he did not ask his foreign pen friends to send him minerals, fossils, anatomical specimens, plants or cultural artefacts, or thanked the addressee for exotic collection items he had received. Particularly fruitful were his excellent contacts to London, the heart of Britain's colonial empire, and to St. Petersburg, the city where the Tsarist Empire organised the exploration of its polar territories.

In studying the biological species 'human', Blumenbach focused specifically on the cranium, which at his time was considered the most revealing part of the skeleton. He assembled a collection of over 300 human skulls from all parts of the world. He published a selection of these crania as annotated illustrations, exemplified here by this famous skull of a Georgian woman which Blumenbach regarded as most aesthetically shaped. The Johann Friedrich Blumenbach – online' project places textual content in juxtaposition to historical illustrations, modern photographs and 3D animations. (*Abbildungen naturhistorischer Gegenstände*, Vol. 6 (1802), no. 51: "Bildschöner Schedel einer Georgianerin" [Beautiful Skull of a Georgian Woman], text and copperplate engraving; photograph [Göttingen University, Medical Faculty, Center of Anatomy, Blumenbach Collection 546 [119]]).

For example, when revising the mineralogy chapter of his *Handbuch der Naturgeschichte* in December 1790, Blumenbach asked the President of the Royal Society, Joseph Banks, for samples of a newly-discovered type of rock from Australia and of adamantine spar from East India or China. He received both in January of 1791 and incorporated his analytical results in the revised edition of his *Handbuch* that appeared the same year. However, things did not always go smoothly: several collection items from the Pacific region that the HMS *Bounty* was supposed to supply to Blumenbach were lost when the crew mutinied and the ship failed to return to Europe. By contrast, with great regularity Blumenbach received specimens from Russia's Siberian provinces, sent from St. Petersburg by the aristocrat Georg Thomas von Asch (1729–1807), a Göttingen alumnus.

Blumenbach's Skull Collection

Blumenbach's mission to unite materials from all over the world for natural history purposes is most impressively illustrated by his famous collection of human

crania (see article by Michael Schultz, this Volume). Blumenbach's 1775 dissertation entitled *De generis humani varietate nativa* (*On the natural varieties of the human species*) was based on the first few of these skulls. By the time of his death, they numbered over 300, among them crania from pre-Columbian inhabitants of Peru and antique Germanic and Roman skulls, artificially deformed crania from Anatolia and specimens from Polynesia and South Asia. On the basis of this material, Blumenbach developed his theory that all human 'varieties' belonged to one and the same biological species. In his *Decades collectionis suae craniorum* (1790–1828), Blumenbach published an annotated selection of these skulls with illustrations.

Blumenbach stands at the beginning of the modern scientific debate about the origin of life, the origin of species, monogenesis, polygenesis, and racial issues – a debate that continues today. By emphasising the unity of the human species, Blumenbach established science-based anti-racism. Already during his lifetime, Blumenbach's dissertation was the subject of extensive debates and became instrumentalised in several different ways. All the same, his subdivision of humankind into five varieties was less significant than his contention that all humans belong to the same species. This theory of oneness helped serve a humanitarian policy that opposed the slave

trade, propagated the emancipation of black slaves in the New World, and, in particular, advocated equal rights for black people. During the first half of 19th century, Blumenbach's name became synonymous throughout the western world with liberalism in science and politics, embodied by the 'unity of humanity' and 'emancipation for the negro'.

Collection Objects as Drivers of Research

How close the relationship between collecting and publishing was for Blumenbach is reflected by the fact that the exhibits displayed at the Academic Museum under his curatorship were categorised according to the same classification as in his Manual. Blumenbach's interests and insights reflect the growth of his collections; there are numerous prominent examples of the dynamic interdependence between additions to Blumenbach's collection and advances in his research. For instance, by examining cranial shapes, he tried to consolidate the diversity of man's physical appearances into several exemplary types. In his dissertation, he had originally postulated four such distinctive types: European, African, Asiatic and American. Once Blumenbach had obtained and analysed human crania from the Pacific region, he added to his system a fifth type that he called 'Malay'.

He revised his 'System of Mammalia' in a similar vein: in 1800, someone he was corresponding with from the United States sent him a live female opossum. Later, when the animal died, Blumenbach examined its anatomy. The observations made on the marsupial's reproductive organs culminated in an essay appearing in 1802 which presented Blumenbach's 'Improved System of Mammalia'. In both cases, the common characteristic appeared to be that the advancements in his research

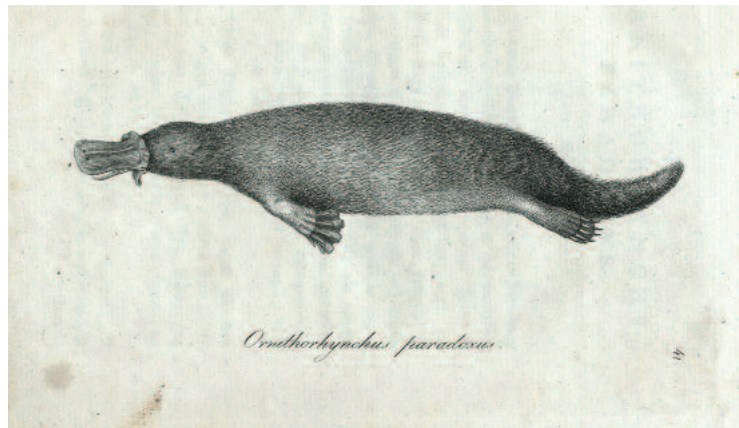
Blumenbach's network of correspondents provided him with collection items from all corners of the globe. One example is this ritual robe of a Tungusic Shaman from a Siberian expedition, donated by Georg Thomas von Asch in 1788.



were driven by the ability for him to empirically examine new objects with own eyes. In other words, his drive was not inspired by information from the literature on foreign research alone.

Johann Friedrich Blumenbach – online

The Göttingen-run ‘Johann Friedrich Blumenbach – online’ project expands upon such observations. As part of its digitisation of Blumenbach’s publications, the project will be creating links between the documents and existing collection material. On the one hand, this is facilitated by the large number of collection items that have been preserved and are still identifiable. In the case of Albrecht von Haller, Blumenbach’s prominent predecessor in Göttingen, for example, this does not apply: Haller’s anatomical specimens no longer exist. On the other hand, the latest electronic media allow documents to be enhanced with added visual attributes to an extent that was hitherto inconceivable. Thereby, the ‘Johann Friedrich Blumenbach – online’ project is striving to identify all collection items Blumenbach mentioned in his works and – insofar as they are available – to create hyperlinks in the text that take the reader to high-resolution images of the objects. Viewable with a mouse click, high-resolution photographs, stereoscopic images and 3D animations will be annotated with identifiers and descriptions of the specimens in accordance with current standards, including metadata and documents citing prove-



In 1800, Joseph Banks sent Blumenbach a preserved duck-billed *platypus* from Australia – “the only one in existence in Europe outside of England”, as he proudly announced in a journal essay shortly thereafter. The zoological description of the genus ‘*ornithorhynchus*’ still used today, dates back to Blumenbach’s proposal. (Copperplate engraving from *Abbildungen naturhistorischer Gegenstände*, Vol. 5 (1799), No. 41).

nance and ownership history. This information can be searched and sorted independent of the texts in a multitude of ways, including by region of origin, donator or epoch, for example. The hyperlinked references that go in mirrored directions – from text to specimen and from specimen to text, i.e. to all relevant written passages in Blumenbach’s collected works – create a novel way of accessing Blumenbach’s world of ideas and thoughts through concrete objects in the collection.

A Virtual Research Environment

The digital texts with their hyperlinks to the collection objects are available online, thus affording global accessibility. This online world gives researchers the chance to explore and experience in detail the methodology applied by a natural scientist working two centuries ago, and enables them to gain insights into their conditionality. Were the specimens available to Blumenbach complete and representative? Might a specimen have exhibited peculiarities that

Blumenbach was not able to appreciate as such and that might have led to misinterpretation? What observations did the specimens permit? What did Blumenbach see and what might he have overlooked? In this context, the direct comparison of modern photographs of the specimens with the illustrations passed on by Blumenbach – like those in his illustrated plate works *Abbildungen naturhistorischer Gegenstände* (1796–1810) – provide a plethora of answers. What do Blumenbach’s engraved copper plates demonstrate? What stands out? What is obscured? And by using collection objects still extant today, but not mentioned by Blumenbach, we can discover which

Whenever reasonable and possible in terms of conservation, the digital edition of ‘Blumenbach – online’ will offer three-dimensional animations of the collection objects. The 360° views will be produced from a series of 100 digital images captured in an automatic camera box and compiled on a computer. Online users can view the object from every perspective and zoom in and out on details. The mineral specimen seen in the picture is a sample of siliceous sinter from the Siberian peninsula of Kamchatka. It was sent to Blumenbach by Georg Thomas von Asch. Blumenbach refers to the indigenous occurrence of this mineral in his *Handbuch der Naturgeschichte* (in the 1807 edition, p. 553.)



materials Blumenbach chose to highlight and which he might have chosen to leave out.

This demonstrates the concrete material conditions under which specific historical scientific insights were gained. Even the mere online availability of non-annotated Blumenbach documents and specimens in and of themselves is invaluable for research. Yet, there are more options than just making digital facsimiles accessible or merely creating links between passages of (primary-source) texts, specimens, translations and reviews utilising hypertext technology. Indeed, within this virtual research environment, it will be possible to acquire individual link sets, which present the interrelationships a specific researcher may need and that are relevant to a particular hypothesis or research question. ◀



Prof. Dr. Nicolaas Rupke, born in 1944, studied biology and geology at the University of Groningen (Netherlands) and geology and the history of science at Princeton (USA) and Oxford (UK). After a series of international research posts, he took up a professorship at the University of Göttingen to teach the history of science and medicine in 1993. Since 2009 he has held a Lower Saxony research chair. Dr. Rupke is known for his studies of nineteenth-century biology, geology, science and religion. At present he is working on a series of nineteenth- and twentieth-century non-Darwinian evolutionary biologists, starting with the Göttingen professor of medicine Johann Friedrich Blumenbach. He is a fellow of Germany's National Academy of Sciences Leopoldina and of the Göttingen Academy of Sciences and Humanities.



Wolfgang Böker, born in 1962, studied history and German philology at the University of Göttingen with an emphasis on medieval diplomatics and Baroque literature. From 1988 to 1992 he worked on the charters of Kaiser Heinrich V. for the Monumenta Germaniae Historica in Munich. He has been employed in the Institute for the History of Science at Göttingen University since 1993, and since 2010 has worked on the Union of German Academies of Sciences and Humanities 'Blumenbach – online' project.





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The liverwort *Plagiochila dependula* in the Andes of Ecuador, collected for the Göttingen University Herbarium in 2004.

Herbaria are collections of dried and archived plants that supply information on the specimens' appearance, origin, collector and collection date. They allow distribution ranges to be reconstructed and serve as important sources of information for creating floras. Collections spanning several centuries – such as that of the Göttingen University Herbarium in the Department of Systematic Botany – can be used to map changes in flora and the migratory routes of 'new inhabitants'. In the same vein, herbaria also function as archives that permanently document research achievements by preserving reference material that can be used to verify the correct specification even after centuries. Here so-called 'type specimens' are especially valuable as the original specimens on which first descriptions of species were based and constitute a kind of 'original measure' of a plant's nomenclature.

New Life for Old Plants

The Importance of Biomolecular Research on Botanical Collections

Jochen Heinrichs

Herbaria in the Molecular Age

For many centuries, plants were primarily subjected to morphological study. The relationships between plants were derived from comparisons of their interior and external structures, while past evolutionary and dispersal events were reconstructed from fossil findings. As before, morphological studies continue to make up an integral part of botanical research. Taken on their own merits, morphological surveys frequently tend to be pushed to their limits, given that plants in general do not have an abundance of distinguishing features and the independent development of the same characteristic states in non-closely related groups encumbers the reconstruction of their actual phylogenetic relationships. These facts have caused morphological research to stagnate to a certain extent.

For around two decades now, phylogenetic relationships of plants have been identified by comparative analysis of their genetic information. As soon the genetic exchange between populations stops taking place, permanent changes (mutations) build up in their deoxyribonucleic acid (DNA). In simple terms, this

means that the longer various species develop apart from each other, the greater will be the differences in their DNA sequences. Based on these sequential differences, phylogenetic trees can be developed which are often statistically more reliable than phylogenetic trees based on morphological datasets. This is because the information content of molecular data is usually substantially greater than when datasets based on a few morphological features are used.

Not only do DNA studies enable the reconstruction of phylogenetic relationships, but also allow conclusions to be drawn about the plants' evolutionary chronology and migratory routes. These data can improve our knowledge about the diversification and extinction events of the past. Knowledge about past processes enables the modelling of future developments, such as changes in plant populations and distribution ranges under a warming terrestrial atmosphere.

Meanwhile, the extraction of genomic DNA from younger herbarium specimens has become standard practice. But it is also growing more commonplace that

successful extractions are performed on old specimens, some of which were collected as far back as in the 19th century. Herbaria are thus moving into the spotlight as DNA resources utilised by modern research where their specimens are being examined by a multitude of molecular methods that were inconceivable just a few decades ago.

Over the past twenty years, the Göttingen Herbarium – home to plants from all corners of the globe – has received extensive material from Central Asia as well as from the tropics in the New and Old World alongside its numerous specimens from Europe and North America. These fresh samples are particularly suited for molecular study and have been loaned out to international institutions across North America, Europe, Asia and Australia. In turn, these institutions provide 'DNA specimens' to Göttingen; many specialised journals and third-party funding organisations not only require that the sequencing be documented in an internet database (e.g. 'GenBank'), but that the respective reference specimens additionally be deposited with a public collection.

Proprietary Research

The University's Herbarium is affiliated with the Department of Systematic Botany at the Albrecht von Haller Institute of Plant Sciences. In recent years, the Department of Systematic Botany's research has focused on biogeography and the taxonomy of spore plants, especially ferns and liverworts. As well as leading to a better understanding of the evolution of characteristics, the newly generated molecular phylogenetic trees have caused extensive modifications to be made to the classification of the groups here. Through molecular datasets, only those morphological features are determined that are truly suitable for identifying taxonomic relationships.

DNA Taxonomy / Integrative Taxonomy

Many plant species are insufficiently known, especially in the tropics. To achieve a better understanding of these plants, descriptions and identification keys need to be provided and valid names found for each. Traditionally, morphological studies of herbarium specimens and living material are used for such processing work.

This type of research requires years of devotion to the studied group and progress is often very slow. Given the dramatic extinction of species and the small number of plant taxonomists, it is desirable to have new approaches that allow faster access to previously unprocessed plant groups.

An extensive DNA phylogenetic tree can be generated within a few months and illustrates the phylogenetic relationships that would not be identified at all or not until after years of study if morphological methods were applied exclusively. Accordingly, Göttingen has switched to identifying plant species using a combination of molecular and morphological datasets. Such 'integrative taxonomy' delivers faster answers than the traditional morphological work, whilst also leading to more dependable results.

Morphologically Cryptic Species

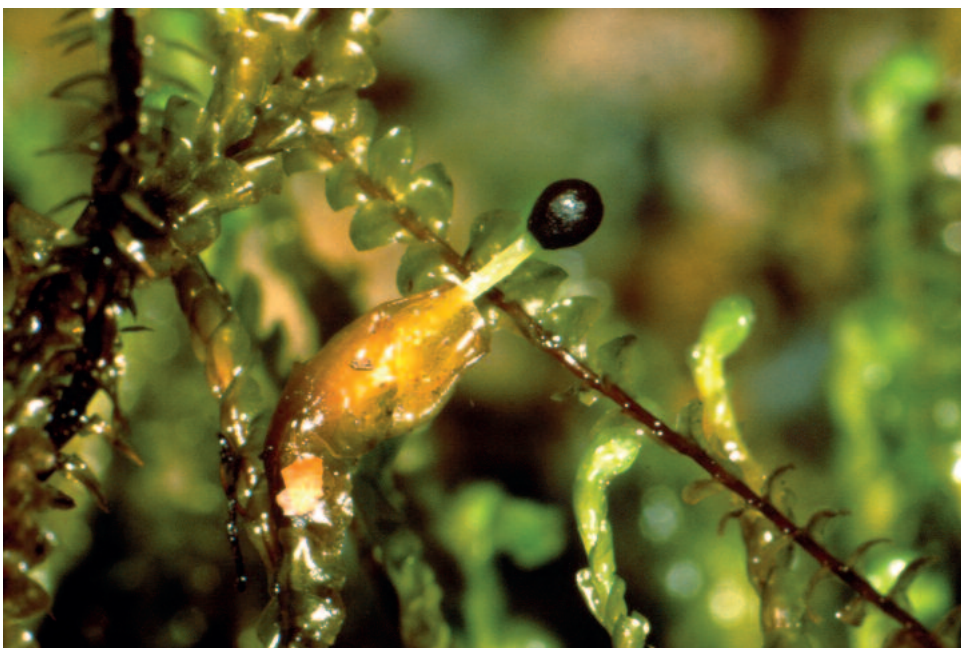
The currently widespread morphological-typological species concept is based on the assumption that speciation processes lead to morphological differentiation. If this supposition proves valid, plant individuals could be allocated to a species by virtue of their

appearance. A series of molecular studies is questioning this assumption. In fact, numerous genetically independent entities (called 'biological species') exist that exhibit no parallel morphological separation. These findings have led to the adoption of the 'cryptic species' concept. How high the proportion of cryptic species is in global diversity is currently unclear. Nevertheless, a number of pioneering studies suggest the likelihood that morphology-based appraisals of the diversity do not completely capture the true circumstances. In fact, it can be assumed that there are many previously undocumented biological entities in existence which potentially have an inherent indicator function; by documenting them, it is hoped that a better characterisation of ecosystems will be possible. Within the spore plants, accumulating evidence is pointing to numerous previously undetected or misinterpreted 'cryptic species' that at best show minute differences to other species. Even botanically well-characterised Europe appears to harbour undetected plant species. For instance, *Frullania tamarisci*, a liverwort widely distributed throughout Europe, contains at least three independent species. Work on the liverwort genera *Metzgeria*, *Porella* and *Ptilidium* is delivering further evidence for previously undetected species. These findings illustrate the need to subject the numerous herbarium specimens of morphologically defined species from the entire dispersal area to molecular study in order to identify their actual diversity. For this, the extensive inventories of the Göttingen Herbarium will certainly be useful.

Biogeography

Biogeography is the study of the distribution of living creatures on earth and its causalities. For a long time, biogeographical reconstructions were made based on fossils and the dispersal of living species,

The liverwort *Plagiochila fuscolutea* in the Andes of Bolivia. The Göttingen Herbarium houses 115 vouchers of this species from various parts of tropical America.



whereas current dispersal regions and those of fossils are brought into connection with geological processes and climatic changes. Such reconstructions are difficult, especially for species groups for which no or only a few fossils are known. Today, it is possible to draw certain conclusions from variations in the DNA sequences of living species that indicate the chronological time-line of the evolutionary processes that have led to our current diversity.

As demonstrated by their fossil specimens, ferns and bryophytes

represent very old plant lineages, the existence of which dates as far back as the Paleozoic. However, the few fossils available do not allow any detailed reconstruction of their evolution, making the knowledge on this subject very patchy. Once morphological data was linked with molecular data, it could be shown that the living diversity of mosses and ferns is rather young and developed from the survivors of previous extinction events. Many of the ferns living today, especially 'epiphytes' which are widely spread through-

out the tropics, first developed in geologically young periods as our modern, angiosperm-dominated forests began to grow. This suggests that new ecological niches in the dense, highly structured forests triggered an enhanced diversification of these ferns.

Tropical regions of the earth are regarded as climatically stable over long periods of time, which means that old species can survive here while new species develop simultaneously. This pattern explains the comparatively high diversity in many tropical regions

The University Herbarium

The Herbarium of Göttingen University is one of the most important institutions of its kind in Germany. It houses around 800,000 labelled plant specimens from all parts of the world. Amongst these are more than 12,000 types that served in original descriptions of species. The specimens are used for both morphological studies (revisions, floras, dispersal maps) and molecular studies (phylogenetic tree reconstruction, analytical chemistry).

The oldest collections date from the 18th century, including plants from the southern hemisphere gathered by Georg Forster during the second voyage of James Cook as well as German and Swiss specimens collected by the universal scholar Albrecht von Haller. The centrepiece of the Göttingen collections is the herbarium of the plant taxonomist and geobotanist August Grisebach, which not only features his own collections from Europe, but also contains comprehensive specimen series from South America and the West Indies along with plants from Asia and North Africa.

Other meaningful historical collections were compiled by Friedrich Bartling, Georg Friedrich Wilhelm Meyer, Hermann Graf zu Solms-Laubach (Europe), Johann Maria Hildebrandt (Madagascar), Albert Peter (Europe and Africa), Cyrus Pringle (Mexico) and Georg August Zenker (Cameroon). In recent decades, comprehensive collections from Europe, Asia and South America have been added, including vascular plants and 60,000 bryophytes. The herbarium is well integrated in the international botanical research network, receiving several hundred inquiries for specimens every year.

Thanks to the generous third-party funding raised in past years, it has been possible to present important partial collections on the Internet. To date, the 'type herbarium', Georg Forster's South Sea collection and parts of the cryptogam herbaria have been digitised. A catalogue provides information and data on the historical collections and biographical data on the botanists represented at the Göttingen Herbarium.

Jochen Heinrichs

Type specimen of the flowering plant *Ipomoea calophylla* collected in Cuba in the 1860s.



Herbarium specimen of the liverwort *displasiolejeunea pellucida*, growing on the leaf of a fern. Liverwort plant material was used for DNA extraction.

compared to the usually species-poor temperate areas. Due to the more extreme climatic fluctuations, a greater number of younger elements are found here because many old species have died out, for example as a result of the ice ages. In former glacial regions, a genetic impoverishment is often seen, even within species, presumably because only a few indi-

Reconstructing the chronology of diversification processes produces new facts about the population biology of plants. In the second half of the 20th century, the common assumption prevailed that plants have stable areas and 'migrate' with the slow drift of the continents. As part of this process, the subpopulations of a species living on the continents drifting

continental areas populated by plants are the result of dispersal processes. A biogeographical reconstruction of *Platycterium*, the well-known stag horn fern, showed that one species currently living in South America had African ancestors and presumably migrated to South America by the long-distance airborne flight of its spores. Similar long-distance dispersal events have been reconstructed for the liverworts *Bryopteris*, *Herbertus* and *Plagiochila*, proving that the development of distribution ranges is attributable to more multifaceted processes than had been presumed in the era of 'vicariance biogeography'.

Thus, by documenting molecular variation, inferences can be made about the changes in diversity taking place over time and space. Appraisals of the chronology of evolutionary processes can be used to link geological events to climatic fluctuations and thereby identify parallels between the main lineages of plants. The analytical methods employed for such purposes are constantly being perfected. In the not too distant future, we can anticipate increasingly more reliable reconstructions that will decisively further our understanding of evolution. The 'rootstock' of this work is the genomic DNA obtainable from herbarium specimens.

Future Trends: Barcoding

For several years now, intensive efforts have been made to identify all organisms living in the biosphere by 'DNA barcoding'. Sets of molecular markers are expected to produce a taxonomy of species based on their DNA sequencing. That way, it will be possible to identify living organisms and allocate material that is atypical or only preserved in fragments without the help of the few taxonomists around. In general, barcode reference samples have to be compared with type specimens and then permanently preserved



Photos: Jochen Heinrichs

viduals survived in the ice ages. The current populations stemming from these individuals are still genetically less variable compared to many tropical populations. Molecular studies conducted on many plants samples have elucidated the patterns described and allowed the reconstruction of 'refuge spaces' where the species survived extreme climatic situations to later advance farther into the landscape.

apart continued to develop so far apart that ultimately new species evolved. This is called 'geographic vicariance'. Molecular phylogenetic trees can be used to reconstruct plant migration routes by mapping the dispersal regions of the species alive today to draw conclusions about the regions their ancestors originated from. Such studies generally run counter to the 'classical' vicariance scenarios, suggesting that many inter-

so that any potential taxonomic errors can be rectified later. The Göttingen Herbarium is involved in the currently ongoing 'German Barcode of Life' (GBOL) project and will be providing reference specimens.

Looking Forward

Research work relies on the tools of its time and methodologies are constantly evolving. Molecular and morphological approaches are not contradictory; rather they create a synergistic whole. The herbaria of a few decades ago were viewed as a document-bound branch of traditional research. Thanks to the explosion in working methods, they have been catapulted into the focus of research groups needing to tap herbarial data. As reference collections, herbaria themselves are also simultaneously producing new research results. In the near future, this status is most unlikely to change. The Göttingen Herbarium's to-do list contains further



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improvements to the infrastructure and inventory documentation as well as the incorporation of new collections, including numerous reference specimens from Göttingen's Departments of Plant Ecology and Vegetation Science. Currently, the herbarial inventories are mostly stored in historical wooden cupboards or provision-

ally on former bookshelves. The problem of space makes it difficult to allocate new entries to their proper places. Moving the collection to a new building would solve many curatorial problems and make the Göttingen Herbarium optimally positioned to enter the new millennium. ◀

Publications by the Department of Systematic Botany with Herbarium:

<http://www.uni-goettingen.de/en/185775.html>





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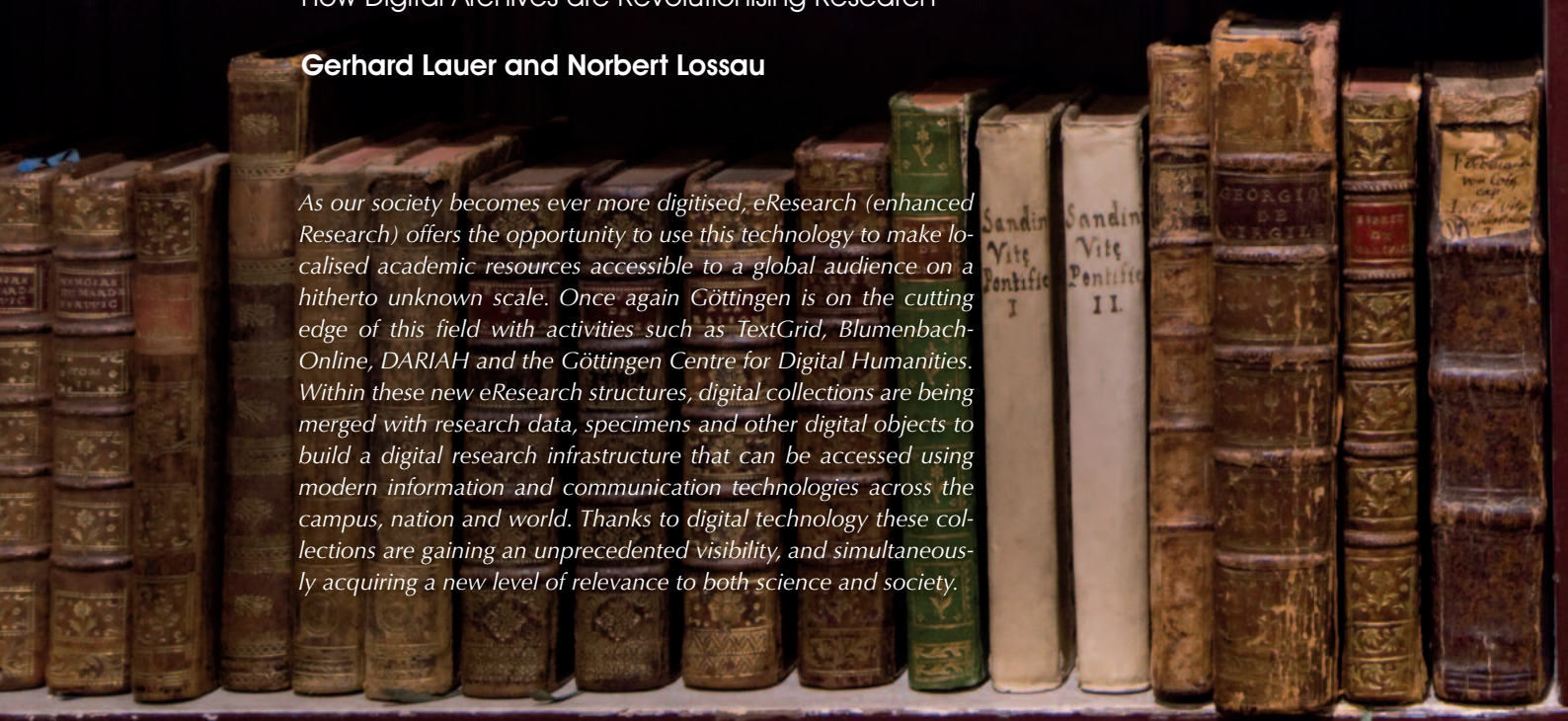


Giving Collections a Global Voice

How Digital Archives are Revolutionising Research

Gerhard Lauer and Norbert Lossau

As our society becomes ever more digitised, eResearch (enhanced Research) offers the opportunity to use this technology to make localised academic resources accessible to a global audience on a hitherto unknown scale. Once again Göttingen is on the cutting edge of this field with activities such as TextGrid, Blumenbach-Online, DARIAH and the Göttingen Centre for Digital Humanities. Within these new eResearch structures, digital collections are being merged with research data, specimens and other digital objects to build a digital research infrastructure that can be accessed using modern information and communication technologies across the campus, nation and world. Thanks to digital technology these collections are gaining an unprecedented visibility, and simultaneously acquiring a new level of relevance to both science and society.





In 1943, amidst the desperate resistance of the Warsaw Ghetto against its German occupiers, the Jewish fighters buried more than 28,000 papers, photographs, posters, sketches and hand-written records in tin cans and milk jugs. Although hardly any of these fighters survived the resistance, the transcripts they buried were unearthed in cellars from under the rubble during the period between 1946 and 1950. Today,

these documents stand as testimony to the fight for personal dignity and are considered a UNESCO world cultural heritage.

The Underground Archive of the Warsaw Ghetto is located there, at the Jewish Historical Institute. This is where the documents are collected, archived and restored, if necessary, and where they are also made accessible for research purposes or public exhibitions. For decades, all of this

work has been the key mission of memory institutions like the Jewish Historical Institute in Warsaw. Similar to many other institutes, museums and collections, an organisation like the Warsaw Institute upholds a social mandate to make their collection available to every interested party, but even more so to those who want to preserve the memories of the resistance. Preserving such memories not only means preserving documents, but also requires a linking of the collection to other testimonials of the era. Oftentimes, it is not until the documents are linked that fates can be given names, that pictures can be explained with captions and that each report can be assigned to its proper place. For them to remain a living part of our cultural memory, collections depend on such linkages.

Nothing in the recent past has brought these collections back to life more than digitisation. This may seem odd, because for many of us computers and the new media symbolise a fast-paced, short-lived exchange of information. No collection wants to have only the 15 minutes of fame that the American pop artist Andy Warhol predicted back in 1968 that future art would have. Indeed, collections need time to come to life and evolve. At first glimpse, the digital world would appear far removed from these goals. But then again, to believe that would be succumbing to a common cultural stereotype. Chaim Gertner, the Director of the Yad Vashem Documentation Centre, impressively demonstrated the reason for this misconception at the recent inauguration of the newest digital humanities project in Göttingen. He makes a twofold argument. Digitisation gives collections a voice by making them accessible to a global audience on a hitherto unknown scale. In fact, this concept becomes rather obvious if you think about collections like those in the Warsaw Underground

Israel, Jerusalem, Yad Vashem Holocaust History Museum. View into the photo cupola in the 'Hall of Names'. Photo: Ullstein Bild



Archive or at Yad Vashem. Thanks to the internet, the testimonial documents can now reach readers around the world and even in countries where denial of the Holocaust continues to be propagated to this day. For such commemorative institutions, the mere dissemination of data in and of itself is more than just a way to maximise synergies. The digital public is an entirely different one and its size alone fundamentally changes the nature of the issue. Survivors can sign on and share

their knowledge with others; individuals who never even heard of the devastation can find out about what actually happened back then. Thanks to their digital distribution, the collections can draw on a new community and thereby gain the advantage of keeping the subject of the Holocaust alive in the various ongoing social discourses. The structural shift in the audience set loose by digital media has particularly affected museums, libraries, archives and their collections.

The closely interrelated second argument posed by Chaim Gertner was that digitisation expands collections in terms of both quantity and depth in a way that conventional methods could not dream of accomplishing. This is particularly due to the fact that computers enable vast amounts of collection data to be processed, but also create much more depth. Names entered in civil registries can be compared, deportation lists can be linked to the victim's numbers. Families who were torn

The Herzog August Bibliothek in Wolfenbüttel

One of the University of Göttingen's most esteemed institutional partners, the Herzog August Bibliothek in Wolfenbüttel, is currently working in concert with the University to develop the Göttingen Centre for Digital Humanities (see accompanying article). Through this initiative, the invaluable collections of both institutions are being made digitally accessible to scholars around the world.

As one of the oldest libraries in the world to have survived to the present without sustaining any losses to its collections, the Herzog August Bibliothek is a place of research and study for European cultural history of the medieval and early modern period. The library's historical holdings provide an archive of western culture that is unique in its breadth and depth; with incunabula, prints and special collections as well as graphic prints and maps, the exploration of Europe's collective body of knowledge is virtually unlimited in its possibilities.

After its founding by Duke Herzog Julius zu Braunschweig-Lüneburg in the year 1572, under its namesake Duke August the li-

brary went on to become one of the largest libraries of its era, and by 1666 it housed 135,000 printed works and manuscripts. Some even called it 'the eighth wonder of the world'. Alongside Northern Germany's unique collection of manuscripts to which Henry the Lion's Gospel and one of the most splendid illuminated manuscripts of the Mirror of the Saxons belong, the library owns numerous, highly comprehensive special collections and deposits, including important testimonials to book art from the incunabula era right up to the 20th century. It has been under the direct authority of the Ministry for Science and Culture of Lower Saxony since 1989.

As a crucible for the humanities, the Herzog August Bibliothek is a place where collecting and research go hand in hand. The synergies fostered by experimental approaches have produced new insights and modifications to research paradigms; in particular, the library is actively involved in the development of digital standards. Today the library enjoys an excellent national and international reputation as a collection in itself

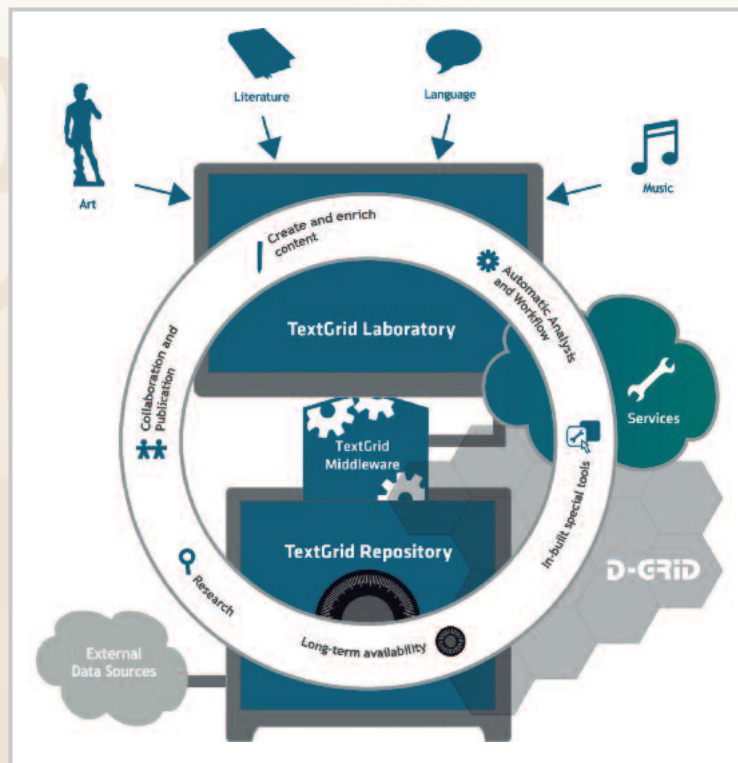
and as an innovative research centre, offering guests and users an extensive and diverse programme of scholarship and culture.

HAB/red.

Photo: Herzog August Bibliothek



The joint project TextGrid aims to support access to and exchange of data in the arts and humanities by means of modern information technology.



printed works from the 18th century has been an integral part of its long-term strategy of providing access to cultural heritage material and specialised literature pertinent to research. That too has changed research and public access, now that a fast-growing number of what were virtually inaccessible volumes can be analysed for research purposes. But also the relationships between source texts and research literature can be digitally linked: vast volumes of research can be systematically searched by computers to find relevant publications, while researchers can compare their own findings against the search results. The political dimensions this takes on are immeasurable. Whereas more and more of the world's knowledge is being monopolised by fewer and fewer organisations (such as Google, for example), it is important that as many libraries as possible can make as much of this replicated knowledge publicly accessible. The growing legal complications relating to copyrights and the juxtaposed economic interests have become equally prominent research themes in Göttingen. Certainly, the digitisation of collections is much more than just the scanning of books. More than ever before, data, collections, research methods and their legal and political frameworks are interwoven into the conditions of a digital society. And that changes the importance of collections per se.

Gone are the days when one was only concerned with collection pieces, inventories of books or printed collections. The 'Blumenbach-Online' project running at the University and the Göttingen Academy of Sciences and Humanities not only digitally edits printed publications by the Göttingen scholar and proto-Darwinist Johann Friedrich Blumenbach. In addition to these publications, it also digitises the anthropologi-

apart and scattered across great geographical distances can re-identify their family ties. This is what digitisation of the collections makes possible. Today, we know the names of around four million of the people who were exterminated during the heinous murdering of European Jews. This is because digital methods are being employed at Yad Vashem and many other places with similar collections. So certainly, exactly the opposite is true with respect to what the culturally critical stereotype of the digital world would suggest: digitisation delivers an elementary service to the cultural mission of such collections and does so on a scale so broad that nobody would have dared to imagine several years ago.

In his contribution to the 2007 yearbook published by the Göttingen Academy of Sciences and Humanities, the British computer scientist Luciano Floridi described the "reontologisation" of the world caused by its digitisation. By this, he was referring to the re-engineered state of reality arising

from the incorporation of digital information into previously familiar objects, data and collections. For over a decade now, this digital expansion of the world, its unimagined possibilities and its frequently dramatic consequences have been a paramount topic at Göttingen University, especially at the Göttingen State and University Library and its institutional partners. Disciplines like archaeology digitally capture the data on their digs and digitise their findings. In musicology, digital methods are used to compare handwritings in order to identify historical authorships. Social scientists are studying the impact of social networks; political scientists are discussing the political infrastructures required by a digital society. In the field of jurisprudence, the problems of copyrights and media law have been topics of debate for a long time. At the University Library, the digitisation of the huge inventory of books and the indexing of historical collections such as those involved in the initiative to catalogue German

cal, botanical and geological objects Blumenbach used to examine and analyse. A digital edition linking the texts with a variety of collection objects, i.e. Blumenbach's scholarly publications with the objects of his research, is one further step in the digitisation of collections that will change this research and other research asso-

ciated with the fields of the history of science, geology, and even botany and anthropology (see also the article by Nicolaas Rupke and Wolfgang Böker, this volume). The same applies analogously to the likes of archaeology. Archaeology digs are not just expensive, but can only be carried out once, whereas only a mere fraction of

findings have been recorded and published to date. Now, using digital technologies such as terrain-mapping laser scanners, digs can be surveyed precisely and documented for later analysis. Gigantic amounts of findings, albeit on thousands of fragments, can still be recorded and published. But, above all, the digitised findings

The Göttingen Centre for Digital Humanities

Nowadays, digital texts, digital libraries and new media are inextricable parts of research in many humanities and social science disciplines. Through them, it is not only the objects to be studied by the humanities and social sciences that are altered, but also the hypotheses they pose and the methodologies they apply to the study of said objects. Nevertheless, scholars in the humanities and social sciences are often not sufficiently familiar with computer-based methods and procedures. Conversely, digital infrastructures are not sufficiently equipped to meet the needs of the disciplines in the humanities and social sciences. A systematic integration of computer-based methodologies in teaching is repeatedly lacking. To counteract these deficits, the Göttingen Centre for Digital Humanities was founded in 2011.

The Göttingen Centre for Digital Humanities (GCDH) is a place where interests in digital research amalgamate. The disciplines represented range from Egyptology to business information systems, from musicology through media law to linguistics and literature – all seeking to traverse innovative pathways across the humanities and social sciences. The mission of the GCDH is to initiate and support eResearch projects in the humanities and social sciences and

thereby expand the University's teaching programme and promote the transfer of knowledge to digital infrastructures. Highly specialised projects such as the creation of a digital corpus of the Coptic language or setting up virtual research environments and establishing grid technologies are just some of its tasks. Scholars and scientists can come to the GCDH with questions concerning digital methods for their new projects and receive help with their research. The next few years will see relevant teaching initiatives put in place in cooperation with the Centre for Computational Sciences, starting with a Bachelor degree programme. Working together with the State and University Library and the GWDG, the GCDH will help us to develop digital infrastructures for basic services with a range of special tools.

For the coming year 2012, the GCDH is planning its first projects and inaugural events. By partnering with projects like 'Digital Research Infrastructure in the Arts and Humanities (DARIAH)', the GCDH is shaping the future for a prosperous digital research landscape in Germany and Europe. This includes developing solutions that provide scholars, academics and scientists with bodies of research and research tools that are not dependent on location, but situated in a virtual research

environment, or solutions that enable the design of degree programmes to prepare students for research in the digitised world of the 21st century. In addition to an international summer school and an international Digital Humanities Conference held in the autumn, a lecture series with international participants is planned that will present all the possibilities that are opened up when the humanities and social sciences go digital.

The GCDH is funded by the State and University Library, as well as by five faculties at Göttingen University – the Faculties of Law, Philosophy (lead faculty), Social Sciences, Theology and Economic Sciences – and works together with the Göttingen Academy of Sciences and Humanities, the Max Planck Society and the Max Planck Digital Library as well as the Herzog August Bibliothek in Wolfenbüttel. The Centre is managed by a board of directors on which the managing director Professor Gerhard Lauer sits along with Professor Claudia Keser, Dr. Joost Kremers, Professor Otto Rienhoff, Professor Volker Wittke and Professor Norbert Lossau. The academic coordination is run by Dr. Juan Garcés. Since September 2011, the GCDH is located in the Heyne-Haus in Papendiek 16.

Juan Garcés

COLLECTIONS – WISDOM, INSIGHT, INNOVATION

can be stored in repositories for comparison with other digs. This generates research data of such complexity that novel and sustainable research opportunities are opened up, for instance when the development of cultural techniques like the manufacture of certain types of vases or metals can be traced over longer eras and across larger cultural regions. Here, too, Göttingen University is involved and committed to playing a leading role in evolving digitally supported methods.

In general, the focus of digital modernisation is indeed shifting away from inventories, towards methods and infrastructures. Statistical methods like those that capture the literary history of the novel or establish the authorship of handwritten music are becoming

construction of a liberal arts-focused infrastructure in Germany and Europe.

It all started with the digitisation of library books. Next, a digitisation centre was erected, followed by the foundation of the University Library's own research and development department. By setting up the Göttingen Centre for Digital Humanities (see accompanying article), Göttingen University, together with the Göttingen Academy of Sciences and Humanities, the Max Planck Digital Library and the Herzog August Bibliothek in Wolfenbüttel, has taken another important step forward in making the collections digitally accessible on a global network. Collections are thus far from static; on the contrary, digitisation enlivens them, thereby in

current research resources like those generated in other fields such as particle physics in the LHC at CERN, Switzerland, by astronomy at the Very Large Telescope array (VLT) in Paranal, Chile or by polar and deep-sea exploration on the research ship Aurora Borealis, to name a few. In many countries, a research trend can be observed that takes the historical concept behind a collection and transfers it to research data by aiming to permanently preserve selected information for current or future utilisation within other research contexts. The museum and library halls that used to house the collections of past centuries are now enriched by 'repositories' or digital archives for research data. The data have to be annotated and the substance of the contents ex-

The Göttingen State and University Library (SUB) – the modern building.
Photo: Marc Oliver Schultz



ing increasingly important in humanities-related disciplines. Very large collections of millions of words and hundreds of thousands of pages can be amalgamated in virtual research landscapes into research corpora and structured in a way that enables the study of historical linguistic development. Here as well Göttingen is leading the field. With TextGrid, Göttingen is running a singularly unique text-based grid that creates a digital research environment for textual science in the humanities. Within a similar project named DARIAH (Digital Research Infrastructure for the Arts and Humanities), Göttingen is managing the

turn altering the academic and scientific disciplines that work with these kinds of collections.

It would not be an exaggeration to say that, in the coming years, collections – especially those in digital form – will stimulate research in the humanities and social sciences in a vastly broader scope than previously. That is when collections, as at the time of their inception, move beyond being cultural heritages or donations to museums, but become a source of data and information for cutting-edge research. From the perspective of computer science, this is where collections become indistinguishable from

explored and interpreted. At the same time, care must be taken to ensure that the information from this fast-paced digital age is made permanently accessible in order to keep research results reproducible, whilst stimulating researchers to pursue additional hypotheses and questions.

As recently as last year, Neelie Kroes, Vice President of the European Commission and Commissioner for the 'Digital Agenda', introduced Europe's future vision of a modern research infrastructure under the motto "unlocking the full value of data". Unquestionably, the term "full value" should also be interpreted in financial

terms: not rarely do the costs for generating research data run into the millions, even billions – a fact that truly underscores the need for multipurpose utilization.

The University's new Institutional Strategy within the framework of the Excellence Initiative maximises the full value of not only the University's diverse collections. Within a new eResearch framework, digital collections are being merged with research data, specimens and other digital objects to build a digital research infrastructure that can be accessed using modern information and communication technologies across the whole campus, and nationally and internationally as well. The tradition of the collections – now driven by the innovative power of the digital age – has proven the exceptional attractiveness of Göttingen as a research location yet again. ◀



Prof. Dr. Gerhard Lauer, born in 1962, studied philosophy, musicology, and Jewish and German studies at the Universities of Saarland, Tübingen and Munich. He completed his doctorate in Munich in 1992 on the topic of the scientific history of exile, and his habilitation in 2000 on Jewish literature in the early modern age. Since 2002 he has taught German philology at the University of Göttingen, where his main research interests are the history of literature, the cognitive prerequisites for literature and digital humanities. He is a member of the Göttingen Academy of Sciences and Humanities, co-editor of the Journal of Literary Theory and founding member of the Courant Research Centre's 'Text Structures'.



Prof. Dr. Norbert Lossau, born in 1962, studied Finno-Ugric philology and Scandinavian studies at the Universities of Bonn and Göttingen, where he received his PhD in 1991. After working as a founding director of both the Göttingen Centre for Retrospective Digitalisation at the State and University Library (SUB) and of the Digital Library at the University of Oxford (UK), he spent four years as managing director of the library at the University of Bielefeld before returning to the SUB in 2006. In 2011 he was named an honorary professor of the Humboldt University in Berlin. His main research interests include new paradigms for publishing and working with digital information as well as the construction of national and international research infrastructures.

The Göttingen State and University Library (SUB) – the modern building by night
Photo: Marc Oliver Schultz



Natural Sciences and Mathematics

Old Botanical Garden

Untere Karspüle 2
37073 Göttingen
Phone: +49 (0)551 39-5755
Web: www.uni-goettingen.de/en/108651.html
Email: gklasse@uni-goettingen.de
Open daily 8 a.m. to 6.30 p.m. (outdoor garden), 8 a.m. to 3 p.m. (greenhouses)
Thematic and group tours by arrangement

Experimental Botanical Garden

Grisebachstraße 1a
37077 Göttingen
Phone: +49 (0)551 39-5713, -5725
Web: www.uni-goettingen.de/en/44267.html
Email: rcallau@uni-goettingen.de
Free access (outside areas)
Open daily 9 a.m. to 3 p.m. (Alpine House), access to scholars and students by arrangement (experimental greenhouses)



Forest Botanical Garden and Arboretum

Büsgenweg 2
37077 Göttingen
Phone: +49 (0)551 39-3492, -3482
Web: www.uni-goettingen.de/en/9050.html
Email: vmeng@gwdg.de
Free access, guided tours by arrangement

University Herbarium

Untere Karspüle 2
37073 Göttingen
Phone: +49 (0)551 39-22220
Web: www.uni-goettingen.de/de/157034.html
Email: jheinri@uni-goettingen.de
Open: Mon – Fri 8 a.m. to 5 p.m. and by arrangement

Pharmacology Reference Collection

Untere Karspüle 2
37073 Göttingen
Phone: +49 (0)551 39-22220
Email: jheinri@uni-goettingen.de
Access to scholars by arrangement

Museum of Geological Sciences, Collections and Geopark

Goldschmidtstraße 1–5
37077 Göttingen
Phone: +49 (0)551 39-7998
Web: www.geomuseum.uni-goettingen.de
Email: mreich@gwdg.de
Open: Mon – Fri 9 a.m. to 5 p.m. and Sunday 10 a.m. to 1 p.m. as well as the first Sunday of each month from 10 a.m. to 4 p.m. (Museum)
Free access (Geopark)
Guided tours by arrangement

Göttingen Culture Collection of Algae

Nikolausberger Weg 18
37073 Göttingen
Phone: +49 (0)551 39-5740, -7868
Web: epsag.uni-goettingen.de
Email: epsag@uni-goettingen.de
Open by arrangement



Forest Zoology and Wildlife Biology Collections

Büsgenweg 3
37077 Göttingen
Phone: +49 (0)551 39-3687
Web: www.uni-goettingen.de/en/71672.html and www.uni-goettingen.de/en/71680.html
Email: bweissb@gwdg.de
Access to scholars and students by arrangement



Zoological Museum

Berliner Straße 28
37073 Göttingen
Phone: +49 (0)551 39-5463, -5524
Web: www.uni-goettingen.de/en/65520.html
Email: gtoerst@gwdg.de
Open: Sun 10 a.m. to 1 p.m. and weekdays by arrangement, entrance €1
Guided tours by arrangement

Museum of Göttingen Chemistry

Tammannstraße 4
37077 Göttingen
Phone: +49 (0)551 39-3326, -3114
Web: www.museum.chemie.uni-goettingen.de
Email: gbeer@gwdg.de
Open by arrangement

Collection of Historical Physics Instruments

Friedrich-Hund Platz 1
37077 Göttingen
Phone: +49 (0)551 39-7604
Web: www.uni-goettingen.de/de/47114.html
Email: mmuenze@uni-goettingen.de
Open: Mondays during term time 4:15 p.m. – 5:15 p.m.
Access for scholars and students by arrangement
Guided tours by arrangement



Collection of Historical Objects at the Institute for Astrophysics

Friedrich-Hund Platz 1
37077 Göttingen
Phone: +49 (0)551 39-4037
Web: www.uni-goettingen.de/en/224019.html
Email: reinsch@astro.physik.uni-goettingen.de
Access for scholars and students by arrangement
Guided tours offered monthly

Collection of Mathematical Models and Instruments

Bunsenstraße 3–5
37073 Göttingen
Phone: +49 (0)551 39-7752
Web: www.math.uni-goettingen.de/historisches/modelcollection.html
Email: sjp@uni-math.gwdg.de
Open daily in accordance with the opening hours of the Mathematical Institute
Guided tours by arrangement

Computing Museum of the Association of Scientific Data Processing

Am Faßberg 11
37077 Göttingen
Phone: +49 (0) 551 201-1539
Web: www.gwdg.de/index.php?id=750
Email: meyszel@gwdg.de
Open daily in accordance with the opening hours of the GWDG
Guided tours once a month

Humanities and Theology

Cast Collection of Antique Sculptures Collection of Original Archaeological Artwork University Coin Cabinet

Nikolausberger Weg 15, 37073 Göttingen
Phone: +49 (0)551 39-7502
Web: wwwuser.gwdg.de/~archaeo/html/sammlung-en.html
Email: dgraepf@gwdg.de
Open: Sun 10 a.m. to 1 p.m. and by arrangement (Cast Collection)
Open by arrangement (Original Collection)
Access to scholars and students by arrangement (Coin Cabinet)

Ethnographic Collection

Theaterplatz 15, 37073 Göttingen
Phone: +49 (0)551 39-7894, -7892
Web: www.uni-goettingen.de/en/28899.html
Email: gkruege1@gwdg.de
Open: Sun 10 a.m. to 1 p.m. and weekdays by arrangement
Guided tours and events held regularly

LIST OF COLLECTIONS

Collection of Historical Anthropology

Bürgerstraße 50
37073 Göttingen
Phone: +49 (0)551 39-3649, -3648
Web: www.uni-goettingen.de/en/21336.html
Email: grosskopf@biologie.uni-goettingen.de
Access to scholars and students by arrangement

University Art Collection

Weender Landstraße 2
37073 Göttingen
Phone: +49 (0)551 39-5093
Web: www.kunstgeschichte.uni-goettingen.de
Email: asors@gwdg.de
Open: Sun 10 a.m. to 1 p.m.

Collection of Musical Instruments

Kurze Geismarstraße 1
37073 Göttingen
Phone: +49 (0)551 39-5075
Web: www.uni-goettingen.de/en/71170.html
Email: K.P.Brenner@phil.uni-goettingen.de
Open: Mondays during term time 4 p.m. to 6 p.m.
and by arrangement
Guided tours by arrangement

Teaching Collection of the Department for Pre- and Proto History

Nikolausberger Weg 15
37073 Göttingen
Phone: +49 (0)551 39-5086
Web: www.uni-goettingen.de/en/125665.html
Email: jschnee@gwdg.de
Open by arrangement

Diplomatic Apparatus

Platz der Göttinger Sieben 5
37073 Göttingen
Phone: +49 (0)551 39-4669, -4667
Web: www.uni-goettingen.de/de/sh/62653.html
Email: hroecke@gwdg.de
Access for scholars and students by arrangement

Historical Collection of Children's Books

Humboldtallee 32
37073 Göttingen
Phone: +49 (0)551 39-5980
Web: www.uni-goettingen.de/en/198387.html
Email: jhoffma@phil.uni-goettingen.de
Open: Mon – Thu: 12 p.m. to 4 p.m. (during term
time), Tue – Wed: 12 p.m. to 2 p.m. (during break
time) and by arrangement
Guided tours by arrangement



Photo: Peter Heller

Medicine

Blumenbach Skull Collection

Kreuzberggring 36
37075 Göttingen
Phone: +49 (0)551 39-7000, -7028
Web: www.anatomie.uni-goettingen.de/de/blumenbach.html
Email: mschult1@gwdg.de
Access for scholars and students by arrangement

Human Embryology Collection (Bleischmidt Collection)

Kreuzberggring 36
37075 Göttingen
Phone: +49 (0)551 39-7000, -7032
Web: www.anatomie.uni-goettingen.de/en/humanembryologie.html
Email: jmaenne@gwdg.de
Open by arrangement

Forensic Medicine Collection

Robert-Koch-Straße 42
37075 Göttingen
Email: grellner@med.uni-goettingen.de
Not accessible at present

Collection on Obstetrics

Göttingen Collection of Medical Moulages

Humboldtallee 36
37073 Göttingen
Phone: +49 (0)551 39-9007
Web: www.egmed.uni-goettingen.de/index.php?id=103
Email: kdrost@gwdg.de
Open: Mon – Fri 8 to 12 p.m. and by arrangement

Heinz Kirchoff's Cultural History Collection: Symbols of the Feminine

Robert-Koch-Straße 40
37075 Göttingen
Phone: +49 (0)551 39-2093
Web: www.kirchoff-sammlung.de
Email: info@kirchoff-sammlung.de
Open daily
Guided tours by arrangement



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