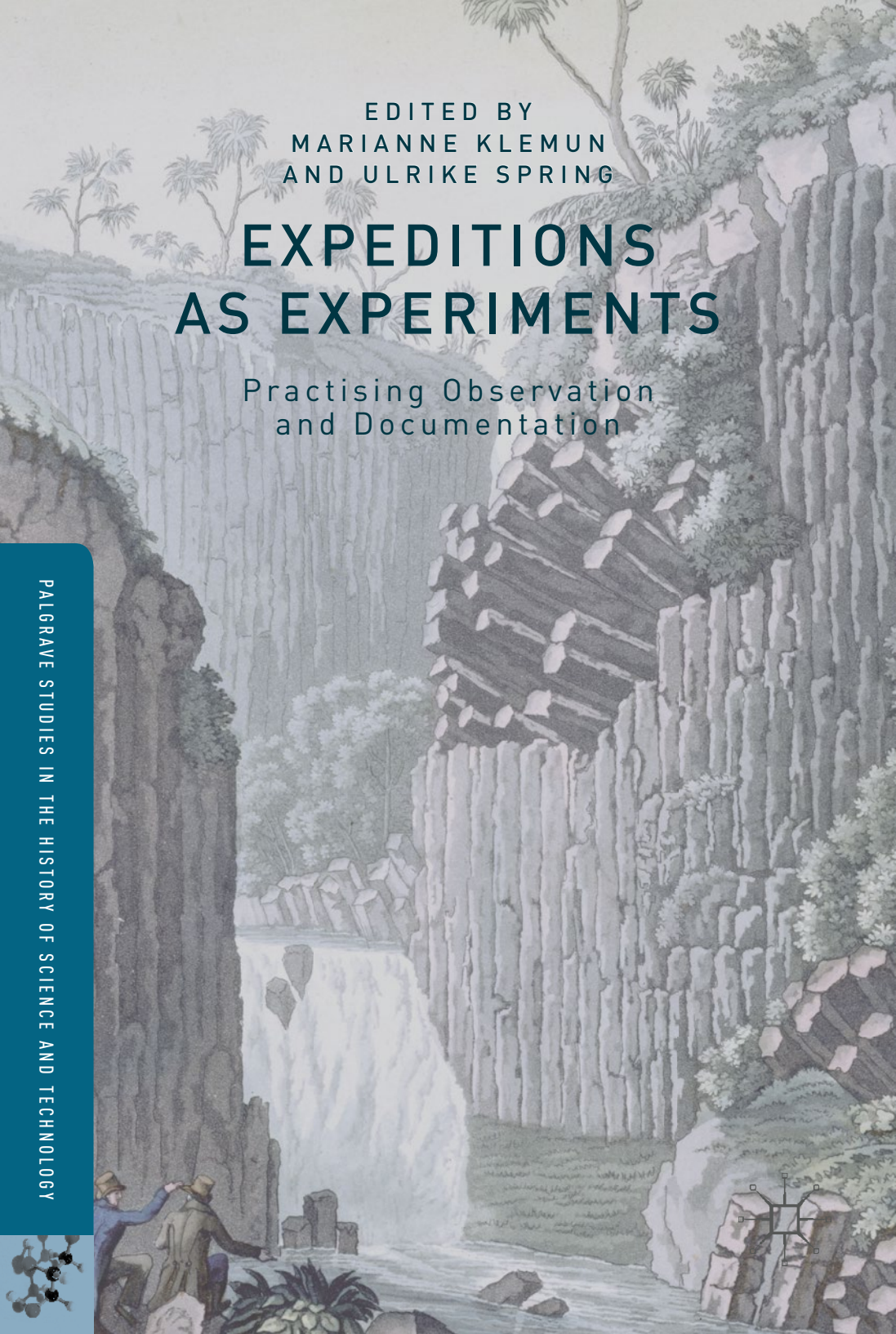

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MARIANNE KLEMUN
AND ULRIKE SPRING

EXPEDITIONS AS EXPERIMENTS

Practising Observation and Documentation

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Marianne Klemun • Ulrike Spring
Editors

Expeditions as Experiments

Practising Observation and Documentation

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Editors
Marianne Klemun
University of Vienna
Austria

Ulrike Spring
Sogn og Fjordane University College
Norway

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Notes on Contributors

Alexandra Cook teaches in the Philosophy Department at the University of Hong Kong and is author of *Jean-Jacques Rousseau and Botany: The Salutary Science* (2013), winner of the 2013 John Thackray Medal of the Society for the history of natural history (London). She is a Fellow of the Linnean Society of London and curated a bilingual exhibit, "Je raffole de la botanique/I am crazy about botany", in the Botanical Garden of Geneva, Switzerland for the 2012 Rousseau tercentenary. She is currently preparing Rousseau's botanical works for publication in the *Œuvres complètes de Rousseau* (Paris: Garnier) and working on the history and epistemology of the herbarium.

Tanja Hammel is a PhD Candidate at the Department of History, University of Basel, Switzerland. She is a member of the Basel Graduate School of History and was an associate member of eikones NCCR Iconic Criticism. This chapter is a result of the Swiss National Science Foundation project no. 146259, *Mary Elizabeth Barber (1818–1899): A History of Knowledge, Gender and Natural History* (2013–2015). She works in the fields of gender history, environmental history and new imperial history. Her publications include articles in *Kronos: Southern African Histories* (2015) and two collected volumes in 2016.

Marianne Klemun is Professor of Modern History, from 2006 to 2012 Vice Dean of the Faculty of Historical and Cultural Studies, University of Vienna, Austria. Publications include (as Guest Editor): *Moved Natural Objects: Spaces in Between* (=*HoST Journal of History of Science and Technology*, vol. 5, 2012) online-journal: http://johost. eu/; (as Ed. together with Hubert Szemethy et al.) *"Once There Was a Student": Other Stories of the University of Vienna* (2015).

Katarina Matiasek graduated in Media Arts from the Academy of Applied Arts Vienna (1994), and in Anthropology from the University of Vienna's Department of Anthropology (1999). She was Artist-in-Residence at the Irish Museum of Modern Art, Dublin (1999) and at the School of the Art Institute, Chicago (2003). Currently, she is writing an interdisciplinary PhD thesis on *Stereo Photography in Viennese Anthropology* at the Department of Anthropology, University of Vienna. Publications include: "Die Welt als Augenhöhle", in *The Moderns—Wie sich das 20. Jahrhundert in Kunst und Wissenschaft erfunden hat*, ed. Cathrin Pichler and Susanne Neuburger (2012).

Johannes Mattes is a lecturer in history at the University of Vienna, a high school teacher and General Secretary of the Austrian Speleological Association. His PhD (2013) is in history of science. Mattes is the author of two books on cultural history and speleology and is co-editor of the peer-reviewed karstological journal *Die Höhle—Zeitschrift für Karst- und Höhlenkunde*.

Teresa Salomé Alves da Mota got a PhD in History and Philosophy of Science by the Faculty of Sciences and Technology of the New University of Lisbon. At the present, she is a post-doctoral researcher at the Interuniversity Centre of History of Science and Technology in Lisbon, Portugal. Her research has focused mainly on the history of the Portuguese Geological Survey, the constitution of a geological community in Portugal, and the practice of geology. In the last couple of years, she has also been interested in the history of science teaching and education.

Peder Roberts is a researcher in the Division of History of Science, Technology and Environment at KTH Royal Institute of Technology, Stockholm. His previous publications include *The European Antarctic: Science and Strategy in Scandinavia and the British Empire* and *The Surveillance Imperative: Geosciences during the Cold War and Beyond* (edited with Simone Turchetti), both with Palgrave. His interests range across the history of science and politics in the polar regions, with a particular focus on resource management and environmental research. His current projects include an edited volume on Antarctica and the humanities, a study of the legacies of mining in Greenland, Svalbard and northern Sweden, and a comparative study of Cold War Arctic research in Canada, Sweden and the USSR.

Kurt Schmutzer studied History and History of Art in Vienna, he is a member of the Austrian Institute of Historical Research (Institut für Österreichische Geschichtsforschung), an archive researcher and editor at the Austrian Broadcasting Corporation, ORF. His research in the field of history of sciences focuses on early nineteenth-century scientific expeditions and their significance for natural history, connections between travelling, collecting and museum practices, as well as relations between European naturalists and indigenous people.

Ulrike Spring is Associate Professor of History at the Department of Social Sciences at Sogn og Fjordane University College, Norway, and a researcher in the project "Making Sense of the Aurora" at the Department of History and Religious Studies at UiT—The Arctic University of Norway. Her research interests include cultures of travel in the nineteenth- and early twentieth-century Arctic, Northern and Central Europe, with a focus on cultural heritage and national identity, as well as the popularization of knowledge through various media, including museums. She has recently published a monograph on the media reception of the Austro-Hungarian polar expedition, *Passagiere des Eises: Polarhelden und arktische Diskurse 1874* (2015, with Johan Schimanski).

Yuko Takigawa is a research associate at the Faculty of Agriculture, Kagawa University, Japan. After graduating from the Department of International and Cultural Studies, Faculty of Liberal Arts at Tsuda College, Japan (BA), she continued to study at the Department of Archaeology and Anthropology, Keble College, University of Oxford, UK, and gained her second BA and MA later. Her current research interests include natural history, focusing on the development of ichthyology, East–West exchanges in the eighteenth and nineteenth centuries, and Japanese fish collections stored in European museums, to reconstruct past environments and landscapes of late nineteenth-century Japan.

Jan Vandersmissen holds a PhD in history from Ghent University. A Research Fellow of the Fonds de la Recherche Scientifique-FNRS since 2012, he is Director of the Centre d'Histoire des Sciences et des Techniques at the University of Liège (Belgium). His publications cover many aspects of colonial history and history of science. In recent studies he has focused on the history of scientific exploration, in particular French and British academic voyages in the Age of Enlightenment. He is a member of the International Academy of the History of Science and the Belgian Royal Academy for Overseas Sciences, and a Fellow of the Smithsonian Institution.

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CHAPTER 1

Expeditions as Experiments: An Introduction

Marianne Klemun and Ulrike Spring

Introduction

For centuries exploratory expeditions have played a dominant role in acquiring knowledge about the world. With the rise of modern science they became a central feature of scientific knowledge gathering and investigation in Western culture. In the nineteenth century the number of scientific expeditions, or, to be more precise, expeditions with a focus on scientific objectives, increased rapidly as a result of growing professionalization and specialization in sciences and the onset of the so-called new imperialism aiming to bring "civilization" to the non-Western world.[1] As Roy MacLeod points out, expeditions and science became inextricably interlinked in the course of the nineteenth century.[2] The belief in scientific analysis, in its global applicability and its capacity to provide knowledge about the world, was a necessary precondition for the growing interest in expeditions; competitive imperialism between states based on growing

M. Klemun (✉)
Department for History, University of Vienna, Vienna, Austria

U. Spring (✉)
Department of Social Sciences, Sogn og Fjordane University College, Sogndal, Norway/Department of History and Religious Studies, UiT - The Arctic University of Norway, Tromsø, Norway

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national movements and increasing international competition,[3] provided an essential context. Today as well, scientific expeditions are an indispensable means of gathering knowledge.

There is an abundance of literature on expeditions, ranging from short descriptions to academic tomes. While earlier research focused on the expeditions themselves and incorporated them into national heroic narratives, in recent years, researchers have paid more attention to what happened before and after the actual expeditions, and contextualized them in a global context. The attention focused on the heroic explorer has increasingly been replaced by an interest in the communication processes among the participants, with the local people met during the expedition as well as with the scientific community. If the focus on the explorer prevails, then it tends to be from a critical perspective on his or (more rarely) her role in nation-building and on gender, class, culture and knowledge production.[4] In this collection, we take a fresh look at the events during the expeditions presented in this volume and the practices they employed to produce scientific knowledge. It continues a tradition strongly influenced by David Philip Miller's and Peter Hanns Reill's by now classic *Visions of Empire*, where scientific practices such as experiment and observation are seen as complex processes situated within a field of power, knowledge and cultural rules.[5] We go one step further, however, and regard the genre of the expedition itself as part of this process of knowledge production: experiments are not just practices executed during expeditions, the act of exploration itself functioned as such an experiment. Moreover, the expedition is a specific scientific practice in itself. As several chapters show, it is also a cultural practice and is embedded within its specific cultural, political and social contexts.

Defining Scientific Expeditions

Expeditions may be called enterprises governed by metropolitan "centres of calculation".[6] Often they are associated with heroic figures like James Cook[7] or Alexander von Humboldt, whose expeditions constituted both a "habitus"[8] and a model for future enterprises. These famous expeditions still determine, to a great extent, the definition of scientific expeditions and the practices involved in the process of gathering knowledge on these journeys. While we by no means want to dismiss the relevance and exemplary function of these famous expeditions, it is nevertheless vital to consider smaller-scale or less well-known explorations in their own right. They may have modelled themselves on their great predecessors and followed instructions

laid out beforehand, yet, each expedition faced different challenges and contexts and had to adapt its practices of observing and collecting accordingly. A focus on expeditions allows us to investigate a variety of knowledge acquisition processes. Moreover, with such a focus we gain more detailed insights into different forms of scientific practices, such as observation, and can investigate to what extent the act of observation is both a result of specific contexts in the field as well as of socialization processes and instructions prepared at the home base.

Before the twentieth century, many scientific expeditions were carried out by members of Western cultures. Not surprisingly, research on expeditions often focuses on the impact these ventures had on the world order and on the territories explored, for instance in terms of imperial strategies[9] or colonial allocation.[10] And without any doubt, expeditions cannot be analysed outside this context. Yet the local knowledge encountered on these expeditions also influenced the Western travellers themselves and had an impact on their practices and understanding of the foreign world.[11] It is also worth remembering that the encounter between expedition members and local populations did not only have exploitative features.[12] Thus in this volume we pay particular attention to the practices that were chosen and applied, as well as to the way knowledge was produced in dialogue with the visited destination, the discovered or observed objects, and other expedition participants and/or local populations during the expeditions. Nor can the procedures during an expedition be seen separately from its repercussions and eventual legacy. We need to understand the interplay between practices and scientific discourses during the expeditions themselves, and more closely investigate the practices and discourses these expeditions both created and were part of in order to comprehend knowledge production and acquisition.

Exploratory expeditions constitute a form of scientific work that has become widespread since the eighteenth century. They had their heyday as spectacular and heroic endeavours during the nineteenth and early twentieth centuries. They are, as Martin Thomas points out, "cultural formations, as distinctive to their epoch as the novel or the photograph".[13] Yet these journeys were diverse in form and content, and definitions of the notion "expedition" have varied accordingly.

We have identified four dominant thematic clusters in this collection which illustrate this heterogeneity: the expedition's motivations and aims, its structure, the division of work, and its epistemological context, for instance by embarking into the unknown. First, expeditions could pursue

different aims, with some placing the focus on geographical exploration[14] or settlement,[15] others concentrating on scientific observation[16] or on economic goals with science playing a minor role. Although in this volume we look at the acquisition of scientific knowledge in particular, a clear-cut distinction from other motives is not always possible or useful. Scientific expeditions usually had a strict plan of investigation before they set out, including a set of specific goals that had to be observed during the course of the expedition and a clear idea of the scientific fields they wished to contribute to. The Latin *expeditio* originates from a military and administrative context and, although the term "expedition" became common for scientific endeavours and thus deviated from its original meaning, the character of an expedition as the *execution* or *completion* of a planned enterprise has survived as one aspect of its multi-layered meaning. The chapters of this volume show the variety of scientific interests that motivated expeditions with their focus on natural history, geology (Teresa Salomé Mota), ichthyology (Yuko Takigawa, Kurt Schmutzer), botany (Alexandra Cook, Tanja Hammel, Jan Vandersmissen), zoology (Jan Vandersmissen), helminthology (Kurt Schmutzer), speleology (Johannes Mattes), physical anthropology (Katarina Matiasek), oceanography (Peder Roberts) and geophysics (Ulrike Spring). However, due to the multi-disciplinary character of scientific fields, deviations from these research plans did occur, and were in fact an integral part of scientific research on these expeditions.

Second, expeditions were structured in various ways: they could be of long or short duration, and they could be carried out by a few people or a larger group. The expeditions investigated in this collection range from journeys of solitary travellers, who embarked on short-term expeditions to well-known areas, to the great expeditions lasting several years which aimed to explore hitherto unknown regions of the world or unknown places of nature. This variety of expeditions allows us to tentatively examine to what extent we may speak of common or even standardized scientific practices. It also gives us insights into different contexts in which knowledge was established. But let us reflect on the question of the duration of an expedition. At first sight, one might define the day of departure as an expedition's beginning and, accordingly, the day of return as its ending. However, scientific expeditions were effectively completed only when the knowledge gathered had been subject to scrutiny by other scholars back home.[17] The scientific community (in its broadest meaning, including the interested public) had to acknowledge the material as "scientific" and the scholars of the expedition as trustworthy and capable of proper scientific observation

and documentation. Similarly, expeditions started long before their actual departure day, and if one were to set a date, it would be the day the idea of the expedition was conceived and articulated for the first time. Peder Roberts reminds us in his chapter that each expedition was not only a singular event but also a process: expeditions built upon previous enterprises and pointed towards future ventures, and at the same time each of them was subject to its own rules depending on circumstances. Scientific expeditions were, in other words, part of specific social, cultural and political contexts, and answered to certain expectations in the way they were structured and performed.

Third, expeditions were based on a division of responsibility. As the examples in this book show, many participants had multiple roles, with doctors working as natural scientists, military officers heading scientific investigation, and self-taught men and women setting off with the help of local guides. Sometimes such roles could be in conflict with each other, as exploration and science do not necessarily complement each other: scientists taking on the role of explorers could fail to implement the necessary practicalities of an expedition, such as preparation for and organization of daily life.[18] Individuals' personalities and their relation to the scientific community have influenced not only the outcome of expeditions but also how the acquired knowledge was viewed back home and in the scientifically interested communities.[19] Martin Thomas argues for differentiating between explorer and expedition: while the former is an individual, the latter is a collective.[20] As Vandersmissen, Schmutzer, Spring and Hammel show in their chapters, some scientist-explorers faced challenges before or after their expeditions because of their social status, their lack of scientific education or their gender. For them, the expeditions were also social experiments where they could test and challenge the boundaries and validity of these social restrictions.

Any form of travel involves processes of displacement, change and entanglement, and this is all the more true for expeditions. The knowledge gathered on these travels is inevitably influenced by context and circumstances, and thus has a dynamic relationship with its surroundings. Most expeditions drew on local knowledge and, in doing so, they combined local and global (or, more commonly in the eighteenth and nineteenth centuries, Western) knowledge. Thus, they allow for an investigation of the complex relationship between metropolis and peripheries, between different colonial aspirations and ascriptions as well as between different regimes of knowledge.[21]

Fourth, expeditions are located within different epistemological contexts of the known (and controlled) versus the unknown (and risky and open-ended). A common feature is that they are ventures based on calculated risk. It is a key objective of every expedition to minimize the risks from the very outset. And yet, at the same time, expeditions explicitly aim at the unknown—in terms of unknown geographical areas, new species or new phenomena. Whereas the course or the outcome of an expedition remains uncertain until its very end, the explorers try to minimize the risks involved by reading of previous expedition reports, by careful preparation and instruction. Expeditions are thus experiments with an uncertain outcome, but where all efforts are made to determine the variables. This is a common feature of the expeditions discussed in this collection, although the degree of risk taken and measures employed to control them varied.

We could name many more than these four clusters to illustrate the difficulty of defining "expeditions". While expeditions constitute a genre, we are aware of the genre's complexity. Hence it might be difficult to decide whether a journey should be seen as an expedition, a voyage of exploration, an extended field trip or even an excursion. While most of the chapters in this book discuss expeditions in their most common meaning as an exploration endeavour, some investigate expeditionary journeys that border on shorter field trips. We have nonetheless decided to include these borderline cases as they illuminate whether the form and duration of expeditions had an impact on the process of knowledge acquisition and on the attribution and definition of authority. Moreover, they enable us to comprehend the often hybrid nature of travel and expedition, and to take into account travels by people who usually could not embark on large expeditions for financial reasons, or gender, or lack of opportunity. In this sense, Tanja Hammel shows that women had to adjust scientific practices to their needs, for instance by combining private journeys and expeditions. Johannes Mattes points out that cave explorers used the term "expeditions" in order to legitimize their exploration and to increase its scientific significance. Alexandra Cook, on the other hand, demonstrates the expeditionary element inherent in Jean-Jacques Rousseau's excursions and prompts us to rethink any clear-cut distinction between expedition and field trip.

As a means to control this heterogeneity, we have decided to use the term "scientific expedition" as an umbrella term, broadly defining a culturally and historically specific mission carried out by a group of people with specific work tasks, and with the aim of reducing the unknown and of

systematically acquiring, collecting and documenting knowledge. David Philip Miller has already pointed out in 1996 that "basic descriptors of scientific activity—for example, experiment or discovery or observation—become […] complex processes of interpretation based in particular cultural practices".[22] As the contributions in this volume show, the production of scientific knowledge cannot be separated from its environment. It is closely (and often explicitly) entangled with various different factors—economic (Yuko Takigawa, Jan Vandersmissen), political, colonial and military (Teresa Salomé Mota, Johannes Mattes, Katarina Matiasek), aesthetic or idealistic (Alexandra Cook, Tanja Hammel, Ulrike Spring), recreational (Johannes Mattes) or national interests (Teresa Salomé Mota, Kurt Schmutzer, Peder Roberts).

Expeditions as Experiments

We propose that to understand expeditions as experiments in the sense of a heuristic tool offers several benefits: experiments provide a platform to try out new constellations of gaining knowledge, new practices, new forms of organization, identification and objectives. In addition, they are also centres of negotiation, they transgress the dichotomy of centre and periphery, and offer a space for cooperation.

We discuss the complex relationship between experiment and expedition by considering four main aspects. First, one possible connotation of expeditions as experiments, in general linguistic terms, refers to expeditions as *daring ventures.* In fact this popular meaning always resonates in narratives on the history of expeditions. It is also found in self-portrayals of the explorers. It implies that all participants undertake risks, make themselves vulnerable and gamble on the outcome. This may be seen as two sides of the same coin: the reward of the venture was its profit, and that profit was the proof of its productivity. The fact that explorers could count on, and insist on the exclusivity of their enterprise, as well as on the knowledge it gained, caused certain expectations and a particular form of self-perception. The profit gained by mastering the adventure manifested itself in the form of a new profile of such travellers.[23] This self-determination was always variable and depended on socio-cultural conditions in the home country. In the symbolic space of the expedition—given the heuristic tool of expeditions as experiments—neutralization (normalization and standardization)[24] was the most characteristic feature in terms of knowledge. Here the former social background of the participants often lost its significance and individ-

uals could reinvent themselves as natural scientists in general, freed from their previous social status. If we understand expeditions as an experimental and multi-faceted space, not only in the sense of a physically located "place of knowledge"[25] but also overlapped by a social and symbolic meaning of space, then this meaning creates its productivity: individuals discover and create their own professional identity within this metaphorical constellation of space. In this sense, Ulrike Spring shows the emerging self-image of expedition members based on the exclusive observation of the rare aurora borealis in the Arctic. Similarly, Jan Vandersmissen and Tanja Hammel demonstrate how travelling naturalists could gain a special profile. Even those working at the fringe of the scientific community were able to make a contribution to the pool of knowledge.

Second, the term "experiment" has a history of its own beyond its timeless abstract and theoretical definition. It is well known that chemistry was based on experiments from its early beginning, but how did experiments shape the negotiation of gaining knowledge in other fields, such as botany, anthropology or geology? The understanding of the term "experiment" differs, depending on the historical context. As Alexandra Cook shows in her case study on Rousseau's "mobile botanical laboratory" from the mid-eighteenth century, contemporaries had a broad understanding of the concept of experimenting in the sense of testing an object or a substance. At this point the expedition became the laboratory in which knowledge—rather than items of nature—was examined against findings published in reports or books.

A third aspect of the relation between expedition and experiment refers to the fact that experiments, unlike field research, are socially exclusive, since only certain individuals have access to the laboratory as a physical space.[26] The same is true for expeditions. As a participant with scientific tasks, and even as a collector, it is necessary to possess certain practical skills, experience in fieldwork, familiarity with expert knowledge on the geographical destination, and also to be part of a network of naturalists.

While the laboratory is characterized to a great extent by social homogeneity, the expedition enterprise generated a more universal community of travelling natural researchers. The objects collected and the phenomena observed on expeditions also created a connection between the participating natural scientists after the event, when objects and experiences were integrated into the already existing collections of material and into further debates.

As a fourth step, we have to discuss the academic aspect of experiments. For us it was intriguing that the term "experiment" refers to a knowledge ideal of modern science. Instead of the ancient practice of contemplation and description, the experiment implies, first and foremost, an active and manipulative intervention in nature. In this sense, the rise of the experiment reversed the Aristotelian separation of nature and technology.[27] Soon modern science was exclusively defined in technological terms. From the seventeenth century at the latest, experiments were thought to be groundbreaking for scientific research by historians of natural philosophy and natural science, although many of them overestimated their importance and ignored taxonomic approaches.[28] Both contemporaries and historians saw laboratories, where experiments were carried out, as ideal locations for the generation of knowledge.[29] Historians of science such as Simon Schaffer and Stephen Shapin have examined this idealization and demonstrated that experiments were dependent on the social acceptance of the performers as *gentlemen*.[30] And yet, in many contexts, experiments retained the timeless aspect of a paradigmatic scientific practice.

Thus, in this volume we want to revalue the significance of expeditions in the cultural zone of knowledge acquisition during a period of fundamental transformation of science, knowledge and society. If expeditions are understood as experiments, they are also a variation of the laboratory, where different practices can be carried out, where the transformation from uncertain knowledge to verified knowledge can be tested, and where different discourses on knowledge are juxtaposed. Laboratories have cultural, social and epistemic dimensions. The historian of science Hans-Jörg Rheinberger defines a laboratory as an "experimental system": "a basic unit of experimental activity combining local, technical, instrumental, institutional, social, and epistemic aspects".[31]

An expedition seen as an "experimental system" brings together an ensemble of techniques, strategies, material circumstances and social actors, and enables us to understand the steps involved in the transformation process from observation to data documentation. It has often been argued that expeditions created a new space of science: new forms of scientific practices and cultural appropriations were established and constituted, an intrinsic link between observation and theory was asserted and events that used to be seen as natural phenomena were considered scientific incidents. The various case studies in this volume investigate and analyse the contributions of expeditions to this process.

We also want to pay attention to the relation between expeditions and field research. To a certain extent, expeditions were contained spaces where knowledge could be collected and analysed and theories could be verified directly in the field. In contrast to the laboratory, field research does not take place in an environment designed by human beings or in a specially equipped building.[32] While laboratories are "placeless places",[33] field research is determined by the peculiarity of a particular place and thus operates not only *in* but also *at* one place. This distinction was formulated at the end of the nineteenth century, describing an ideal situation for which the historian of science Robert E. Kohler asserted different "modes of knowledge production".[34] While in the experiment causes and effects have to be kept apart, the field researcher describes, compares, names and classifies nature in all its complexity. Kohler explains these differences by referring to cultural traditions, and argues that these boundaries, which have been negotiated and redefined since approximately 1890, are fluid.

So let us go back in time again. Several methods established in the laboratory were introduced into field research as instruments or tools. Thus, laboratory standards based on his experiences with chemistry influenced Rousseau's botanical field research, as Alexandra Cook points out in her chapter. Certain methods of collecting and preparing determined the subsequent debate on species, as Kurt Schmutzer shows in detail in his case study. Furthermore, it is important to investigate the function of expeditions according to whether we see them as experiments or highlight the field as their characteristic feature. Or we can refer to both aspects, as Ulrike Spring suggests: as special places of observation such as the Arctic, which served as laboratory as well as the field for studying the rare aurora. The contributions in this volume underpin the significance of place for scientific practices by focusing on different environments, such as Mediterranean as well as tropic and polar areas.

However, expeditions were also spaces of knowledge where technology in general[35] and instruments in particular[36] played a very special role. This is another—and the fifth—reason why we centre on expeditions as experiments rather than on their character as field research. The key features of experiments are interventions. The choice of special circumstances, conditions and instruments before and during the expedition is of pivotal significance. In this sense, the process of choosing a phenomenon for observation might be seen as influenced or even controlled by certain expectations about the outcome of an experiment or an expedition alike. Choosing and controlling a phenomenon as an object of an experiment

is as pivotal as choosing a certain procedure for an expedition, which is already anticipated in the instructions or determined, for instance, by a certain preservation method which affects the results, as Kurt Schmutzer shows in his chapter.

The chapters in this volume stress various aspects of these different relationships between expeditions and experiments. We have arranged them roughly in chronological order to make explicit the changing circumstances under which expeditions were conducted but also to highlight the similarity of the challenges the explorers or travellers had to face across time, from the eighteenth to the twentieth century.

Alexandra Cook's contribution discusses Jean-Jacques Rousseau's sustained engagement with the natural sciences. Looking at his botanical expeditions, she focuses on the methodological inspiration from laboratory experimentation that resulted from his detailed knowledge of chemistry. According to Cook, Rousseau, who claimed that fields adorned with flowers should provide the botanist's "only laboratory", was undoubtedly influenced by the idea of the conventional chemistry laboratory. Cook's analysis is based on a broad eighteenth-century understanding of "*laboratoire*" as the site of the work and "*expérience/experiment*" as a "test", which differs from the strictly modern sense of the term "*expérience*". This meaning, a core aspect of the eighteenth-century understanding of the term "experiment", included activities such as testing procedures. This illuminates Rousseau's understanding of a mobile botanical laboratory, or laboratory in the field, in which elements of experimental methods were crucial as practice. But what was Rousseau testing during his endeavours? His approach included, among other things, techniques of verifying what others had seen or not seen. In so doing, he combined the results of recent accounts and reports with his findings in the field. Causes and effects that would generally have been kept apart in the experimental system constitute, in Rousseau's case, the key to the success of an expedition, in choosing the best guide and the best weather, the most suitable instruments and location.

In his chapter, Jan Vandersmissen examines Jean-André Peyssonnel's work on the classification of corals in the natural order, based on discoveries made during his expeditions in the early eighteenth century. Peyssonnel's innovative work on corals was the result of extensive travels, on the one hand, and of experiments with corals taken from the sea and carried out ashore on the other. These two aspects—expedition and experiment—do not interrelate directly with one another but each complements the other

in an ideal way. Without experiments the expeditions would not have resulted in the revised classification of corals as animals. At the same time, however, Vandersmissen illuminates that the scientific community of the early eighteenth century considered knowledge gained at sea as limited, due to the widespread scepticism towards any generalization of discoveries made during travels. The relationship between centre and periphery was involved in these processes, with the long-unrecognized natural scientist Peyssonnel making a great contribution to the latter.

Vandersmissen shows in detail how Peyssonnel made fruitful use of traditional practices and tools of fishermen, and defined the maritime space as a place of knowledge for himself and his scientific questions. In so doing, Peyssonnel's maritime ventures evolved into an experimental environment to test traditional methods of fishermen. In this context, the fishermen's practical or implicit knowledge gained new value as scientific practice. As a result, Peyssonnel was able to improve his profile as scientific investigator by circulating transcripts of his results. Vandersmissen's chapter shows the reciprocal relationship between theory and practice, between expedition and experiment, as the foundation of research. An ensemble of strategies and techniques during Peyssonnel's maritime expeditions enabled him to classify corals as part of the animal kingdom.

Yuko Takigawa, in her contribution on the Russian Krusenstern expedition (1803–1806), concentrates on a temporal and spatial segment of this venture that was planned as a global circumnavigation. Her main interest is the restricted contact of the explorers with Japanese locals in Nagasaki, after the ship had anchored off the coast of the peninsula and remained there for six months. The visit had pivotal consequences for Japanese ichthyology. Although no member of the expedition was allowed ashore, apart from visiting a designated dwelling house, and fieldwork was thus impossible, certain contacts and exchanges between the natural scientists of the expedition and some Japanese locals did take place, and these were of scientific value. Only a few people had access to the Europeans' residence, which also meant that any contact was socially exclusive, just as in a location devoted to an experiment, in a *placeless place*. Takigawa underlines this comparison by pointing to the most important independent variable in the experimental place of the contact-zone between the Europeans and the Japanese: the shipwrecked Japanese sailors who had previously been brought back to Japan by the expedition and who had to reside with the Europeans. Also, the Japanese government authorized translators who, in accordance with diplomatic protocol, had access to

the Europeans. But what was crucial was the food supply for the ship's crew provided by the Japanese. Fish played a central role, since it was highly esteemed in Japanese cuisine. For the European naturalists, on the other hand, the different fish specimens were welcome objects for investigation and collection. Therefore, fish turned into a dependent variable in this experimental location. Through these objects an extensive network of exchange-relationship emerged. While the Europeans valued and exploited the Japanese local knowledge of edible fish, which they turned into scientific objects, the Japanese admired the Europeans' skills of drawing and preparation, which were quite new to them. Takigawa meticulously traces how the two systems of knowledge—the local Japanese one and the Western systematic scientific one—merged to create new European knowledge of Japanese fish species.

Kurt Schmutzer's chapter, a case study of the debate about the lungfish, analyses the specific scientific outcome of the Austrian Brazil expedition (1817–1835) headed by Johann Natterer. By discussing the impact of different interests, instructions, the framework and individual practices during the journey in the making of an *epistemic thing*, Schmutzer highlights how the discovery of these specimens influenced debates after their arrival in Europe. Due to the great interest in helminths (and not in lungfish only) in Vienna, Natterer had prepared the fish without internal organs. Schmutzer uses the notion of *expeditions as experiments*—paraphrasing Rheinberger's suggestion of experimental systems—by identifying an experimental system within the arrangements for the processes of collecting and preservation in the course of the expedition. The experimental system, in the case of Natterer's expedition, was determined by the special frameworks, instructions and ideas of the Imperial Natural History Museum in Vienna for whom Natterer was collecting: a selection process on the one hand, and, on the other, the production of specific specimens, using specific preparation practices. Thus, these specimens, as epistemic things, prepared during the expedition within an experimental system, were products of an intervention in nature regulated by the controlled procedures of collecting. However, these interventions in the nature of the specimens by preparation (that is, the removal of organs) hindered the understanding of the lungfish as a species between fish and reptile.

Tanja Hammel employs our heuristic tool of looking at expeditions as experiments in a different way, compared to the contributions mentioned above. She considers the genre of travel accounts as a sort of laboratory,

allowing a natural science researcher to withdraw from the scientific community and to find her own way. By referring to the biography of Mary Elizabeth Barber, an English settler in South Africa, and her journeys in the 1870s from Kimberley to Cape Town, Hammel analyses the travel account of a scientific outsider, who turned away from the science of botany and systematic approaches and initially sought to verify Darwin's theory. By addressing racism and transcendental philosophy, Barber succeeded, in this open genre of travel accounts, in reconciling issues of natural selection and of faith. Reflecting on the alleged hierarchy of African tribes according to linguistic competence, Barber developed her own attitude to African society. The autochthonous population, their animism and the relationship of humans to their environment became increasingly a topic of great significance for her. In this she was influenced both by a colonialist understanding and by the concept of animal rights and the humane treatment of working animals, and conducted a study on the attitudes of peoples of different ethnicities in this respect. Her experience with the autochthonous population was an important variable for developing new interests.

In her chapter, Ulrike Spring discusses efforts in the 1870s and 1880s to transform the moving phenomenon of the aurora borealis into a fixed scientific object to be studied. Attempts to reproduce the aurora in a laboratory had so far been futile, and as an aerial phenomenon it could not be collected and brought back to Europe. Hence the Arctic became laboratory and field at the same time. Taking as her starting point the Austro-Hungarian Arctic Expedition (1872–1874), Spring examines the various standardization strategies the participants of the expedition deployed under their leader Carl Weyprecht during and after the expedition in order to make the aurora better understood scientifically. However, as she argues, these attempts at observing and documenting were constantly undermined by the aurora's fleeting and ever-changing character as well as by its spectacular nature, testing the borders between science and art or science and religion as well as of science itself. The expedition itself reflected this ambiguity, having been carried by ice into unknown waters, leaving the outcome of the journey open until its safe return to Norway. One might thus call the expedition an experiment, with its open-endedness, the necessary adaptations to the fiendish environment, and its continuous efforts to retain control over the situation and secure the outcome of the journey. While social hierarchy and division of labour determined not only the expedition's daily life, but also the way in which the results of

the observation processes of the aurora were perceived, the Arctic also functioned as a place where social differences could be suspended and potentially everybody could acquire scientific skills. In this way, the expedition was also a social experiment.

Johannes Mattes focuses on cave studies, a field for which expeditions are essential. He applies the term 'expedition' to travelling in caves and problematizes thus the boundary between speleology and cave exploration as a purely tourist phenomenon. With examples from German-speaking Austria-Hungary and later Austria, Mattes illustrates the proliferation of speleological expeditions. He describes them as a travelling laboratory which allows the testing, trying out and implementation of not only new methods and instruments such as photography and the theodolite, but also organizational and professional issues. Mattes suggests that speleology only came into existence as a discipline—albeit a synthetic one—since scientific institutions started organizing such expeditions. He elaborates his ideas by referring to two such major undertakings, the expeditions into the Gassel-Tropfsteinhöhle cave in Upper Austria in 1924 and into the ice cave Eisriesenwelt near Salzburg in 1921. Particular forms of control of procedure acted as a framework for the experimental design. Strict processes of exclusion as well as inclusion determined the planning of the procedure, which was exclusive not only socially, as in a laboratory where access is limited, but also politically, especially where Jews and women were concerned. Thus cave expeditions proved to be a political field where social developments were negotiated and also prominently presented in the public domain.

Katarina Matiasek analyses stereo photography as a means of anthropological research in Vienna. She shows how this method was first tried and tested on various expeditions and then became established as a reliable instrument. The expeditions she examines constitute an experimental field in which this method, initially a documentation technique, soon developed into a measuring instrument, and finally into an analytical tool. Unlike the free expeditions undertaken by the Viennese anthropologist Rudolf Pöch, the research in POW (prisoner of war) camps during the First World War proved to be very differently organized. They were conditioned by an enclosed location where, as if in a laboratory, the factors of the investigation could be better controlled. While the technique of stereo photography did not fundamentally change in qualitative terms, the concept of space evoked by this method was transformed from "salvage space" to "atavistic space", and then from "hereditary space" to "total space" during the Nazi era.

Peder Roberts discusses two different ways of exploring the deep sea: through oceanographic expedition ships and the bathyscaphe. While the expeditions he focuses on—the Swedish *Albatross* (1947–1948) and the Danish *Galathea* (1950–1952) expeditions—were highly relevant for constituting deep-sea oceanography as a research field, the bathyscaphe remained, to a great extent, a vehicle for testing new technology and providing spectacular feats of deep-sea exploration. In both cases, the ocean became an experimental space for testing existing knowledge and for finding out more about its largely unknown fauna and flora; technology partook in creating this space, as new instruments were devised and tried out. While research carried out from the base of the expedition ships did not allow direct observation of the ocean depths, bathyscaphes did. For the two expeditions this meant that one had to imagine the environment of recovered research objects such as fish or sediments. Hence, the space of the deep sea had to be recreated, as in an experiment. Yet, as Roberts shows, the way the deep sea was approached differed between the expeditions: not only were they embedded in different national discourses but they also used different methods to investigate the data they found. This is an illustrative example of the situatedness of any exploration and scientific research.

Teresa Salomé Mota examines a special geological expedition which set out in 1960 from Portugal—at this time under dictatorship—for the Portuguese colonies in Goa (India) and had to be terminated abruptly in 1961 due to the invasion by Indian troops. In the course of this undertaking, aerial photography was used as a new observation practice that allowed the geological mapping of a landscape that was difficult to access: even though direct intervention in the landscape was limited, aerial photography facilitated greater control. The expedition not only provided the opportunity for geological investigation, it was also of social significance since it increased the social status of the geologists. And yet, social status issues caused problems among the participants of the expedition which had to be socially negotiated. They were triggered by the privileged position of one geologist due to his position at the Lisbon Academy. At the same time, however, geology as a field science provided a welcome opportunity for the Portuguese to prove themselves as a colonial power on the Indian subcontinent, and to match the research of the Indians. Thus, the expedition had an experimental character in that it tested new research practices. In a sense, we might even understand Goa as experimental space, as the Portuguese government was able to reconsider its intentions to combine

political, colonial and scientific interests during a period of colonial competition with the Indian Union.

Division of Work and Questions of Authority

Organization was a key element in preparing expeditions; potential risks and dangers had to be foreseen and various tasks to be carried out during the expedition had to be planned in advance. Appropriate clothing, instruments, food supplies, items for entertainment and education such as books had to be acquired. Not only precise preparations but also a well-functioning division of responsibilities were considered essential preconditions of expeditions, as well as the professionalization of routines in fieldwork, certain practices, instructions and the like. Everyone had their place and particular tasks, while at the same time cooperation between the participants was required. In most cases, a set of instructions was applied based on the experience of previous explorers. Thus every single expedition was part of a tradition of rules and regulations on how to acquire knowledge.[37] In addition, the scholars often depended on a network of travellers and locals who provided them with knowledge and data before or during the enterprise.[38]

While the workload may have been democratically divided, there was a clear hierarchy in place, not only among the participants themselves, but also between the expedition members and the local population. This illustrates the complexity of knowledge production and the impossibility of distinguishing between various forms of knowledge, which is implied by the notion of expeditions as centres of negotiation. Western travellers often saw themselves as carriers of global knowledge and attributed to the local population a mere local understanding. Modern Western science was seen as superior to the local scientific traditions.[39] And yet, as much research and also the chapters of this volume show, knowledge production is a continuous process which cannot be reduced to a dichotomy of local versus global or "Western", or of local population versus Western traveller or colonialist.[40] Moreover, there is no clear-cut definition as to who in fact had local knowledge, which was highly differentiated, for example in regard to expeditions exploring colonial territories or regions in Europe. Not only locals but also representatives of colonial authorities and residents with a colonial background who had become locals (Teresa Salomé Mota, Tanja Hammel), or those who held high positions such as merchants and consuls (Jan Vandersmissen) could belong to this group.

Local knowledge was employed and actively applied in different ways: in finding and naming items (Yuko Takigawa, Kurt Schmutzer), in providing infrastructure (Teresa Salomé Mota), in generally supporting the expedition (Kurt Schmutzer), in the form of guides (Johannes Mattes), in providing necessary information before and during the expedition (Ulrike Spring, Jan Vandersmissen). It could also be found in the metropolitan centre itself, for example through the transport of material and objects between the so-called peripheries and centres. Furthermore, as Tanja Hammel shows in her case study of the white female South African traveller Mary Barber, the relation between locals and more recently settled locals was often characterized by an internal social hierarchy. While local knowledge in general was rarely considered to be equal to the knowledge of the expedition members, it could be and often was acknowledged in scientific work presented or published in the aftermath of the expedition. It was, in other words, an important aspect of the credibility of the expedition enterprise.

Tanja Hammel's contribution points to another issue which had a significant impact on the question of authority: gender. Expeditions were highly gendered enterprises in that they were mostly conducted by men and both reflected and produced specific notions of masculinity in Western societies.[41] Johannes Mattes shows in his chapter that women enjoyed less scientific credibility than men and had to use different strategies to obtain recognition for their knowledge. Different social and professional hierarchies determined not only the division, assignment and manifestation of (scientific) authority during the expeditions, but also affected the processes of observation, documentation and reception. The dividing line ran between leaders and assistants, men and women, wealthy and poor scientists, or, as Kurt Schmutzer shows in his chapter, between travelling naturalists and natural scientists or, to refer to Jan Vandersmissen's contribution, between acknowledged scientists and mere naturalists.

Scientific Practices: Observation and Documentation

There is arguably no other practice for gaining knowledge that is so obvious, fundamental, omnipresent and, at the same time, so ambiguous than observation. In the protagonists' self-representations, observing and collecting predominantly appear as inseparable characteristics of the practices used during the expeditions, as Kurt Schmutzer demonstrates. Observation dominates perception, activation of the senses, the

selection of phenomena and the orientation of questioning and assessment. Distinguishing between *observatio* and *experimentum* had a long tradition,[42] and both served to explore the unknown. But whereas the former was increasingly devalued as mere passive recording and registering, the latter—due to its active role—became more and more appreciated.[43] Ulrike Spring explores what happened when the fleeting ephemeral character of the aurora made the process of observation uncertain. Referring to one of the Austro-Hungarian Arctic expeditions, she demonstrates that both *observatio* and *experimentum* were needed. The registering process during the observation procedure created and developed new terms of classification. Drawings became necessary as mimetic instruments to record observations. In this context, the aurora shifted between being perceived as a natural phenomenon and a scientific object; the expedition, thus, can be seen as an "unfinished experiment" (Spring).

Every observation, of whatever type, is a central component of active questioning. And questioning is directly linked to documentation. This includes the most varied forms of recording, the "little tools of knowledge",[44] lists and labels as well as journals, notebooks, sketches, pictures and instruments. New ways of recording observations have constantly been discovered, and it is for this reason that the productivity of observation is essential to the expedition. Here we may follow Daston and Lunbeck's apt description: "As a practice, observation is an engine of discovery and a bulwark of evidence."[45] Often, observation is not only the means, but also the end, and "a learned reflection as a distinct form for knowledge"[46] with its own standards and conditions. The variations of phenomena and practices, and the question of how to deal with them in the context of both physical and symbolic spaces are at the centre of this volume. Each chapter refers to specific constellations in which a mix of observations and particular documentary activities is discussed.

When focusing on the material aspect of the particular exploratory journey, we have to examine precautions taken and strategies used to ensure that the knowledge gained through observation during an expedition was intersubjectively verifiable. What types of medial configurations of documentation were developed and then used in a standardized way to provide a solid basis for travel as an instrument of discovery in the course of the modern age up to the twentieth century? Or (to put it differently), what kind of standardization and control mechanisms—factors we generally recognize as constitutive for an experiment—were introduced or required of expeditions? Since these different practices correspond to specific and complex cultures of knowledge, we need to take a closer look at this.