5 *The academy that academicised*

1820–1904

This chapter describes the activities of the Academy of Sciences during what must be labelled its heyday. During the 19th century, the natural sciences expanded at universities while, towards the end of the century, various natural phenomena started to affect the lives of an increasing number of people. One consequence of this is that, at the start of the 20th century, people talked of their time as "the age of steam and electricity". The chapter begins with a description of permanent secretary and internationally renowned chemist Jöns Jacob Berzelius' transformation of the Academy of Sciences into an organisation that focused more on the natural sciences, one characterised by support for research. Berzelius' work can be said to have been crowned with complete success just over fifty years after his death when, starting in 1901, the Academy of Sciences was entrusted with naming the Nobel laureates in physics and chemistry. Both these changes were formative in the sense that they had far-reaching consequences for the direction of the Academy. The collections also expanded during the 19th century, particularly the natural history specimens, with significant repercussions for the activities of the Academy of Sciences and for its buildings. This chapter describes how, far into the 20th century, the collections had an increasing influence on the Academy's activities – for better or worse. In parallel, the Academy of Sciences built up research institutions in areas such as marine research and meteorology, examples of fields that contributed to the natural sciences having a greater impact on various 19th-century industries. It is also difficult to overestimate the importance of the Academy of Sciences for Swedish polar expeditions, which often partially aimed to create the right conditions for exploiting natural resources in the Arctic.

Berzelius takes over

For numerous reasons, the Academy of Sciences in the early 19th century has been characterised as an organisation in decline, as was described in the previous chapter.[1] Some people believe that the handful of secretaries that followed Johan Carl Wilcke's tenure from 1796 to 1818 did not really succeed in maintaining activities in the same manner as that of Elvius, Wargentin and Wilcke in the previous fifty or so years. Another reason was that political life in the Gustavian era (1772–1809) showed greater interest in arts and culture than in the sciences; a third reason was the general decline in Swedish natural philosophy and natural history after the great successes of the 18th century.[2] One sign of the times was the new Freedom of the Press Act, introduced in the 1809 Constitution, which meant breaking the Academy of Sciences' hitherto permanent almanac monopoly. Instead, the Academy now had to apply for a renewed monopoly on almanac publishing every twenty years.

But things soon changed. When Jacob Berzelius took over the post of secretary from Olof Swartz in 1818, management at the Academy became considerably more active. There had been visible indications of Berzelius' frenzy a few years previously, when he had published so much in the Academy's *Transactions* that his "expansive production [...] threatened to break the mould".[3] Quite simply, it was difficult to print Berzelius' chemical discoveries at the same rate as his long reports were submitted. For his part, Berzelius did not want to abridge his reports because he believed that studies of nature required detailed descriptions, particularly the methods. The result was an entirely new series of *Transactions of the Academy of Sciences*, which were published every six months from 1813, rather than every three months. Berzelius now had room for long studies within the scope of a single issue.

Occasionally, the decision to publish documents was accompanied by attempts to make the publication's contents more interesting for specialists in the natural sciences. There had been a lack of submissions in the first few decades of the 19th century, possibly due to declining public interest in the natural sciences. The idea for a new series was that it would be more suitable for specialists who preferred foreign publication channels to the Academy's *Transactions*.[4] This change can be described using Berzelius' scientific method, which often aimed to "peel away and limit the influence of what he regarded as non-verifiable speculation".[5] However, this did not stop him from sometimes taking to almost metaphysical arguments, such as when he stressed the roundness and uniformity of atoms.

THE TRANSFORMATION OF THE *TRANSACTIONS* was the first stage in the creation of a more streamlined scientific academy.[6] In 1820, Berzelius' work was crowned with success when the Academy of Sciences received new statutes,

ANNA SUNDSTRÖM was Jacob Berzelius' housekeeper and assistant for almost three decades. In 1836, when he married, she was forced to leave. The portrait was painted by Mårten Eskil Winge and dated 1872, the year after she died. The daguerreotypes of Berzelius and his wife Elisabet (Betty) were taken in Berlin in 1845 by Laura Mitscherlich.

strongly influenced by those of the French Academy of Sciences, where Berzelius had been made a corresponding member a few years previously.[7]

The Academy of Sciences, once again inspired by the academy in France, invested in a new publication series for the interested public: yearbooks on progress in various sciences, such as physics, chemistry, geology, botany, zoology, astronomy and technology. They were published from 1822 (for the year of 1821) until the mid-19th century and contained ambitious overviews of the various disciplines. For the first few years these were published together, with no named authors, and were often 400 to 500 pages long. It seems that 1823 was particularly eventful, as the yearbook contained 620 pages; towards the end of the 1820s, they were printed with a separate section for each discipline.[8] Berzelius involved the researchers employed by the Academy in these yearbooks, but assumed the greatest responsibility in writing about chemistry and geology. He also added technology to this, when the Thamic lecturer Gustaf Magnus Schwartz resigned in 1823 after refusing to comply with the demand that he authored reports for the yearbook.[9]

Romanticism and materialism

Politically, Berzelius was a liberal, especially on education issues. He liked to highlight the practical benefit of science, while opposing the strongly Romantic scientific ideal that was typical of the first half of the 19th century. In Romantic nature research, there was enthusiasm for overarching theoretical systems that included explanations for multiple phenomena at one and the same time.[10] The movement's focus on theoretical reasoning and results can be partially linked to a view of the scientist as someone with an extraordinary capacity for thought, a genius recognised more for their intellectual ability and intuition than for their practical skills in the laboratory or in the field. This interest in theory can also be regarded as a politically conservative reaction to a more liberal tradition of Enlightenment that often accompanied empirically focused research, and which was frequently accused of pedantry.

To further generalise the Romantic view of science, empirical results were interesting if they provided clues to the understanding of larger contexts, but they had no real value in themselves. One consequence of this was the idea of science as a unified mass of knowledge. Often, the basic starting points were a view of the world characterised by idealism, that nature's material expressions were simply manifestations of underlying non-material conditions. Nature was characterised by different forces, an idea that builds on the assumption that we can only learn about the world around us through the forces that affect our senses. For example, unweighable substances – known as imponderables – such as heat, light, electricity and magnetism, were favourite phenomena in physics. Central elements of these natural forces were polarisation and frequencies; these interacted with the senses which, in turn, were based upon the existence of life, consciousness and the spirit. This Romantic vein in natural philosophy and natural history was perhaps most noticeable in biology, which often included studies of the development of living life. Here, idealistic striving could have almost free rein, such as in systematics.[11]

The Romantic view of nature was linked to its research ideals, with the natural scientist's intellectual work being given prominence, rather than material conditions such as laboratory equipment or access to large collections of specimens. Therefore, the idealism that permeated this view of nature also had an impact on the perception of the research process, which was largely considered dependent on the ideas of a few individual geniuses and notions about how natural phenomena were linked and how they could be explained. The cult of the genius in science thus stems from this period, a phenomenon generated by the Romantic view of arts and literature. This would soon come to influence the view of technical innovations.

HOWEVER, THIS WAS BEFORE BERZELIUS was elected to the Academy. His influence as secretary was not limited to the reorganisation of activities, but also affected their content. Berzelius represented a great deal of the front-line opposition to Romanticism, embodying rigid materialism based upon empirical results rather than theoretical speculation, even if, in practice, his research results were not entirely free of Romantically inspired reasoning. The early 19th century saw many expressions of the tension between the two scientific ideals in textbooks and scientific debates, not least opinions about the structure and innermost being of matter. At the Academy of Sciences, this debate came to a head in 1814 when the professor of mathematics at Uppsala, Jöns Svanberg, used his Presiding Committee speech to highlight the importance of quantifying the magnitudes and phenomena under analysis. Opposing this view was the secretary for the minutes, Carl Magnus Arrhenius, who believed that quantifiable materialism was for those who were interested in empiricism but had no ambitions to really explain what was observed. With a more dynamic perspective, the various observations could not only be investigated, but also explained. But the dividing lines between these different scientific ideals were not razor sharp, as evidenced by Arrhenius finding reason to praise Berzelius as a good example in the context.[12]

Education issues

This backwards movement of the Academy in the early 19th century coincided with increasing debate about education issues, as the education system became a central question in policy discussions. There were relatively clear demarcation lines between conservative nationalism, reflected in neo-humanistic ideals, and a more liberal approach that tended to promote practical higher education in "applied schools". Education issues took centre stage in the 1823 Riksdag. Primarily, there was criticism of the 1820 Schools Act, despite it being so new. One problem was how higher education could be organised into practical areas that were not represented at universities, for example technology and agriculture. This resulted in the creation of the Technological Institute in Stockholm in 1826, with the Academy of Sciences' former Thamic lecturer Gustaf Magnus Schwartz as its first head, and an agricultural institute in the county of Skaraborg in 1834, with activities that were taken over by a state-run equivalent in Ultuna, outside Uppsala, in 1848.[13]

In parallel with the discussions of education policy, increased representation in the Riksdag was debated at the end of the 1810s and the early 1820s, something that led to the Academy of Sciences gaining two representatives in the Riksdag's clergy estate. At the same time, the universities also gained broader representation in the Riksdag through the ability to send representatives from their "worldly" faculties, in addition to those who had seats in

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Academic uniform
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the clergy estate due to their positions in the theological faculties.[14] The 1828 Riksdag was the first one in which representatives from the Academy of Sciences participated; they did so until the parliamentary reform that led to the 1866 Parliament Act.[15]

ANOTHER CONSEQUENCE of the Riksdag debates in 1823 was the 1825 appointment of a new inquiry into the country's "public instruction establishments": the Teaching Committee. However, from the time its work started in September 1826 it was popularly known as the Genius Committee.[16] Even if the background to the committee was the issues surrounding military education – not least the new monitorial system, which had been imported from England and was based on teachers functioning as supervisors while teaching was managed by the more able pupils – it soon became an arena for clashes between Romantic and materialistic outlooks, as well as between conservative education ideals, which built upon classical languages and Christianity, and more liberal outlooks that embraced modern languages and natural science.[17] It had no fewer than 23 members, including the most elevated scholars such as Carl A. Agardh, Esaias Tegnér and Jacob Berzelius.[18] Members of the *Växelundervisningssällskapet* [monitorial system society] dominated, but included ten people who were also members of the Academy of Sciences (another seven Genius Committee members were elected after its work had ended in 1828).

One of the issues the committee dealt with was the relationship between university education and what was taught at the various "applied schools", such as the War Academy in Karlberg, the Caroline Medico-Chirurgical Institute and the newly founded Technological Institute, all of which were in Stockholm.[19] Here, Berzelius advocated technical education with strong elements of science and thus proposed a new, more specialised technical institute of higher learning alongside the Technological Institute, which he felt had too much of a practical focus. The relationship between the Caroline Institute and Uppsala University morphed into a conflict that lasted more than fifty years, during which Berzelius claimed that only Stockholm was big enough to provide the number of patients necessary for medical students. Uppsala was welcome to have a medical faculty with research, and more besides, but the actual education of medical students had to be located in Stockholm. In parallel, various suggestions were submitted for moving Uppsala University to Stockholm, or even to merge the universities in Lund and Uppsala and create a central university in Stockholm, Jönköping or Vadstena.[20] A professor from Lund, Esaias Tegnér, who has been named as the source of the idea of a merger, said that if this occurred, the Academy of Sciences should be part of this potential central university.[21] One alternative that was also on the table was moving the practical faculties to Stockholm

– both law and medicine.[22] Yet another variant was to locate humanities in Uppsala and natural sciences in Lund.[23] Similar proposals were discussed in the Genius Committee, where one idea was to close Lund University and convert it into an upper secondary school for southern Sweden, while expanding Uppsala University.[24] Sweden was regarded as just too small for two fully fledged universities. Also, the university in Lund had serious financial problems and, to cover its outgoings, was requesting relatively significant state funding in addition to its income from land donations.[25]

It is clear that the 1820s were years in which knowledge organisations could be questioned from many different perspectives, such as their educational content, geographic location and their interrelationships. The role of the Academy of Sciences was apparently also negotiable. The Genius Committee never actually arrived at a clear proposal because it could not agree on a common approach to vital issues, which were often complicated by clear socio-political drawbacks. Different types of education, for example classical or scientific, were often considered more suitable for certain social categories. The prevailing model was a conservative one that regarded sons as best suited to education and occupations that were not too far removed from those of their father. However, there were enough opponents to such ideas for the committee to end up in a limbo of indecision. According to the same model, daughters were sent to free vocational schools if they were poor, or to the handful of private higher schools for girls if they were not, but this was barely worthy of discussion. The relationship between classical education and the new natural sciences in various forms of education was a contentious issue, and would be discussed throughout the 1800s and well into the 20th century.[26]

At the same time, throughout the 19th century, relationships between the subject areas shifted slowly. For example, at Uppsala University there were, in total, 15 scientific positions in the 1820s, including the relatively poorly paid adjunct positions and unpaid docent posts. After this, around one new position was added every decade until 1860. Ten years later there were 25 positions, which had grown to 35 by 1890. In parallel, wages had increased considerably and job security had improved. The Academy of Sciences had four positions in 1800 and 16 in 1880. An equivalent change could be seen at universities and, to an even greater extent, at the higher education institutions that were founded in the 19th century: Stockholm University College, which was more focused on natural science research than classical subjects and, of course, the Technological Institute and Chalmers in Stockholm and Gothenburg respectively, and other professional education institutions such as agriculturals institutes, veterinary institutes, forestry institutes, et cetera. The increase may seem negligible compared to the modern-day dominance of medicine, technology and natural science at universities and university colleges, but overall it marks a highly significant change in the resources that were available for natural science, medical and technical subjects in higher education and research.[27]

However, all this was still unknown to members of the Genius Committee. Instead, the final result of their work was a disappointment for those forces working for change. Adherents of conservative values won, in the sense that a great deal remained as it had been. No universities were closed or moved. The costs of such a revolution were a natural deterrent, but the main argument against a central university in Stockholm was that "the capital would expose academic youths to too many hazards and temptations".[28] The new "applied schools" that were founded in the 19th century were instead the result of separate decisions by the King in Council. One consequence was that universities received state funding in addition to the income from their original, and subsequent, land donations. From the very beginning, these relatively large grants were a boost that soon contributed to ending the universities' financial problems.

The Academy in the capital

It is clear that the organisation of higher education largely concerns relations between the capital city of Stockholm and the university cities of Uppsala and Lund. Even if the Genius Committee did not achieve any great change in the Swedish system of knowledge formation, there was plenty happening in the first half of the 19th century. As we have seen, a number of new higher professional colleges for physicians, engineers and agriculturalists were established, as well as for pharmacists, veterinary surgeons and foresters. Even if it has been claimed that the Academy of Sciences functioned as something of a science faculty in Stockholm – which, together with the Caroline Institute as a medical faculty and the Technological Institute as a technical faculty, comprised a kind of widespread capital university focusing on the practical sciences – the question is whether its activities were of an adequate scope.[29] It is probably fairer to regard Academy resources, including the Swedish Museum of Natural History's collections, the library and public lectures, as a form of infrastructure for natural science in the capital city.

One part of this infrastructure was the Academy of Sciences' auditorium, which seated 600 and was used for popular science demonstrations; these were not only offered by the Academy, but also by associations and other popular educators who rented the space for events.[30] Scientific societies and

THE AUDITORIUM AT THE ACADEMY OF SCIENCES on Drottninggatan was regularly used by many organisations. This poster announces a meeting held by a national association for women's suffrage in 1916.

DE·SVENSKA KVINNORNAS

RÖSTRÄTTSDAG

FIRAS·PÅ **BIRGITTADAGEN**

DEN·7·OKT.

I VETENSKAPSAKADEMIENS HÖRSAL KL. 8 E.M.

PROGRAM

INVIGNING AV STANDAR · PROLOG · FÖREDRAG AV LANDSFÖRENINGENS ORDFÖRANDE FRÖKEN SIGNE BERGMAN OCH RIKSANTIKVARIEN O. MONTELIUS. SÅNG AV EN DAMKÖR.

BILJETTER TILL 50 ÖRE OCH 1 KR. SÄLJAS I ALLM. TIDNINGSKONTORET, GUST. AD. TORG, PÅ RÖSTRÄTTSBYRÅN, LÄSTMAKAREGATAN 6 SAMT I FOLKETS HUS KIOSK.

A·BÖRTZELLS TR. A-B. STHLM.
1916

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The will of an Ice Age sceptic
p. 513–518

organisations that aimed to educate the public started to become common in Stockholm in the 1880s, such as the Stockholm Workers' Institute, which held popular science lectures and classes almost every day. These were attended by an average of hundreds of people every week, supervised by and with the support of members of the Academy of Sciences.[31] In the second half of the 19th century, specialist associations were founded for experts in geology and physics, for example.[32] The public aspects of natural science expanded toward the end of the 19th century. Museum collections grew. The Geological Museum opened its doors in the early 1870s, around 500 metres south of the Museum of Natural History, in the premises of the Geological Survey of Sweden.[33] The Academy of Sciences and its members supported all these public initiatives.

AT THE END OF THE 1730S, the Academy of Sciences had been created as a meeting place for men of the higher estates from various areas of public life – merchants, officers, pastors, higher officials, men of the estates with an interest in science, university lecturers and others – who wanted to discuss and circulate practical knowledge and thus make it useful. However, in the early 1820s the Academy became a knowledge institution more like the universities and practical university colleges, with instruction and open exhibitions for public improvement. Actually, from this time onward, the Academy of Sciences has been characterised as a government office, and the "most scientific of them all".[34] This transition reflected a general change in the view of how knowledge could best be made accessible and thus useful. The model of a meeting place where one section of society could discuss new findings and how they could be utilised, was thus replaced by a model that built upon instructing students taking courses with a practical focus. France had been a role model after the 1789 revolution but, in the first decades of the 19th century, Prussia began to be regarded as the country that was best at developing this new model.

The reforms in formative processes during the 1810s and 1820s had, under Berzelius' authoritarian leadership, created a more hard-hitting Academy of Sciences, one that was also a better fit for the era's demands on science and for benefit. Nor were matters made worse by moving to larger premises at the end of the 1820s.

THE ACADEMY MAINTAINED ITS POSITION as the capital's science hub until at least the end of the 1870s, when Stockholm University College was founded. This was a new and progressive alternative to the traditional universities in Uppsala and Lund, which was noticeable in its relatively high number of female students. Until 1907, the new university college had a single faculty of natural science, one more focused on industry and business than on officialdom, indicated by it not being able to award degrees until 1904. Instead, students had to ask the traditional universities to award them a bachelor or licentiate degree.

Still, one clear disadvantage for Stockholm University College in relation to the traditional universities was its shaky financial situation which, along with an unclear allocation of work between the teaching council and the board, contributed to numerous conflicts in the 1890s, for example on the right to award degrees. These conflicts primarily concerned whether it should continue with its relatively free role in higher education, or strive to become more like the traditional universities in Uppsala and Lund, with the ability to award degrees.[35] However, these types of obligations were accompanied by restrictions to the freedom of teachers at the university college, because awarding degrees entailed the governance and control of instruction methods and course content.

Prominent lecturers at the college were also Academy members, such as mathematician Hjalmar Holmgren, geologist Alfred Törnebohm and biologists Veit Wittrock and Frits Smitt. As more lecturers were gradually recruited, they were rapidly elected to the Academy of Sciences, for example mathematician Gösta Mittag-Leffler, chemist Otto Pettersson and physicist Svante Arrhenius.[36] One exception was the famous zoologist and popular educator Wilhelm Leche, who was employed as a lecturer at Stockholm University College in 1880 and as a professor in 1884. Despite his great contributions to teaching activities, which included well-equipped anatomy collections, and despite his support for Darwinism, a theory that quickly found many supporters in the Academy of Sciences and at the Museum of Natural Sciences, Leche was not elected to the Academy until 1921. This has been explained as being due to his "influential opponents" in the Academy.[37] It is likely that his independent political radicalism played a role in this.

As the university college grew and incorporated more activities of the Academy of Sciences, including its own collections of specimens and instruments, activities at the Academy itself became marginalised. This process was accentuated by the Academy's move to Frescati in the 1910s, just a few years after Stockholm University College gained a beautiful new building close to the observatory and the Royal Institute of Technology. At this time, Stockholm University College had become more like the other establishments of higher education, with more institutional similarities between them, in that university research had become more specialised and the university college was finally able to award degrees to its students.[38]


paleacea
Lachnaea paleacea Banks
Passerina
Ericoides α
H. Th.
Passerina
Ericoides β
Passer
capitata β
H. Th.
Passerina
rigida
Passerina
ciliata
Passerina
uniflora
Passerina
nervosa
H. Th.
Passerina
canescens
H. Th.
Pass.
unifl.
D. calycina
Daphne
D. nitida Vahl
Daphne dioica

The importance of the collections and their expansion

Even if the Academy of Sciences declined in importance, as regards Stockholm's public scientific life and education system – both because of its relocation and the simultaneous expansion of Stockholm University College and other professional institutes of education – its various collections, instruments and natural history specimens, not least the library, were still vital resources for the city's scientists, as well as for the ability of the Academy to promote its own research. Due to the use of the collections, the Academy still functioned as a scientific support organisation in Stockholm and thus as a knowledge organisation of the time.

Between the two formative processes that comprise the beginning and end of this chapter – the former, which entailed an academisation of the Academy of Sciences due to Berzelius' secretaryship in 1818 and the new statutes two years later, and the latter, characterised by the first Nobel prizes in 1901 and the new statutes of 1904 – the natural sciences can, in general, be said to have followed two main paths. Meteorology is a good example of the first, which involves approaching nature through analysis and quantification. In physics and chemistry this meant both exact and abstract approaches to the object under investigation, a method that was called natural philosophy in the preceding century. The second primary path was that of natural history, which influenced botany and zoology, as well as geology. Here, investigations rested more on accumulated knowledge and experience, an almost sensual relationship to the objects being investigated in the field, at research stations or on expeditions.

It is true that the 19th century also saw a merger of these two approaches. This was perhaps most noticeable in the rapid development of physiology and in refined mineral analyses of geology, which were certainly motivated by the potentially pecuniary benefit of being able to evaluate the metal content of finds.[39] If meteorology was an example of the analytical side, the expansion of the collections and the Museum of Natural History is an equally good example of the cumulative one. This was expressed by the museum being one of the very first Swedish institutions to adopt Darwinism and thus being one of the greatest defenders of the theory of evolution in the 1870s. The Academy of Sciences has also been called "the stronghold of Darwinism in Sweden".[40] Contributing factors in this were that the museum was free of the university's traditional idealism and that its employees were relatively

SEEDS IN THE ARCHIVE OF JOHAN EMANUEL WIKSTRÖM.
Wikström was Professor Bergianus 1818–1856 and thus also the director of the Botany Department of the Swedish Museum of Natural History.

young.[41] Both meteorology and biology fitted into the activities of the Academy of Sciences and developed strongly in the 19th century.

The instrument collection

However, before we get into these areas, we will first see how the Academy of Sciences, came to influence technical instruction in Stockholm through its instrument and apparatus collection. The previous chapter described how the Academy of Sciences' instrument collection was used in the Thamic lectures during the 18th century, among other things, but at the start of the 19th century these activities had also taken a backward step, like the Academy of Sciences as a whole. To re-establish its Thamic commitments, the Academy decided that the focus of its instruction should no longer be mathematics and natural science, but technology.

The task of taking over the Thamic lectureship and its new purpose went to a graduate at the Assay Office, Gustaf Magnus Schwartz, who started as a technology lecturer at the Academy of Sciences in 1809.[42] His position was strengthened in 1812 with the title of *teknologie professor*; he was elected to the Academy and promoted to the position of first controller at the Assay Office. Schwartz' competence and enthusiasm contributed to his instruction in technology which, from 1811, also included the duties of the Thamic lecturer.

Even more important was that even before his employment by the Academy of Sciences, he had come into conflict with a promising Academy member, Berzelius, who, a few years later, would advance to secretary of the Academy. During the 1810s, Berzelius and Schwartz developed an increasingly bitter enmity that came to full expression in the 1820s and the following years. This was a major factor in Schwartz' resignation from the positions of Thamic lecturer and *teknologie professor* at the Academy in 1823.[43]

AT THIS TIME, the establishment of more advanced technical education was being debated in the Riksdag, with numerous proposals being submitted.[44] Just two weeks after resigning as the Academy's *teknologie professor*, Schwartz was named as the "deserving and excellent professor and technologist" who was suitable for the task of investigating how activities at the mechanical school could be expanded so it more likened the new technical colleges on the continent, with the *École polytechnique* in Paris as the most famous role model.[45] And so it was, with Schwartz' proposal for an "institute for practical education in the crafts" being sent to the Academy of Sciences and the Board of Trade for consultation.

At the Academy of Sciences, Berzelius rejected the proposal. His reasoning was that a mechanical school already existed and, besides, the Academy had already organised lectures using a replacement for Schwartz. But when the issue was brought up for discussion within the Academy, the contribution of one member led to opinion swinging in favour of the proposal for a new institution for technical learning.[46] This was primarily due to a reference to the sciences, "the use of which has had the most forceful effect on what one calls really productive professions".[47] The Board of Trade also approved the proposal and, in the end, the only criticism was from craftsmen's organisations. It therefore appears to have been a fairly simple decision for the King in Council, in 1826, to establish the Technological Institute; this had premises in central Stockholm that had so far housed the Academy of Agriculture's model chamber, and had Schwartz as its head.[48] However, this did not mean that Berzelius' attempts to stop its activities, or at least those of its leader, were over – he simply put them on hold. When Berzelius eventually launched a new attack on Schwartz, it was both a complaint about his manner of leading the Technological Institute and the strong practical focus of teaching at the institute, at the expense of the natural sciences.[49] But because this duel should be regarded as a conflict between the secretary of the Academy and director of the Technological Institute, we will leave it here.

AT THE ACADEMY OF SCIENCES, the Thamic lectures continued with the new Thamic lecturer, Erik Gustaf Pasch, one of Berzelius' chemistry students from Uppsala, who taught at the Caroline Institute as *farmacie adjunkt*. Pasch was, in accordance with tradition, elected into the Academy within a few years; he was also a link with the Patriotic Society, where he was secretary and rapporteur to the technical section of the agricultural department. He had a fairly significant collection of instruments for use in his technical instruction at the Academy, which expanded with another 200 items in 1823, purchased privately from A. N. Edelcrantz.[50] There were also instruments that Berzelius was able to provide.[51] Otherwise, Pasch is primarily remembered as the inventor of safety matches, which use red rather than white phosphorus and so need to be struck on a special surface. He received the patent on his idea in 1844. However, red phosphorus was expensive and of low quality, which was a contributing factor in Pasch dying a pauper in 1862, despite determined attempts to commercialise his invention.

By the mid-19th century, the Technological Institute in Stockholm had become properly established and, in 1846, it received new statutes after Schwartz resigned as head. Instruction was to be more science and mathematics-based under the new management, even if many practical elements remained. At any rate, one consequence of the new arrangements at the Technological Institute, and Pasch's increasing interest in commercialising his safety match, appears to have been that the Academy of Sciences changed the focus of the Thamic lectures.[52] Pasch's declining health also contributed to these changes. In 1843, an assistant was employed to help him. This was

SAFETY MATCHES manufactured by J. S. Bagge & Co:s Kemiska Fabrik at the end of the 1840s.

Lars Johan Wallmark, who maintained the physics instrument collection, a position that was called *custos machinarum*. Pasch was given leave in 1846 and never returned to the post of Thamic lecturer, so Wallmark also left his position and, two years later, was deputy director-general of the Technological Institute.[53] Still, to some extent, Wallmark lived on at the Academy – partly through the founding of the Wallmark Prize, partly through his instrument collection coming into the possession of the Academy of Sciences after his death in the mid-1850s.

MEANWHILE, THE ACADEMY OF SCIENCES identified physics and chemistry as its main subjects and employed a physicist and a chemist in 1850.[54] These were an assistant professor of physics from Uppsala, Erik Edlund, and chemist Lars Fredrik Svanberg, who worked for Berzelius and had taught physics and chemistry at the Academy of War Sciences in Karlberg; they took over the Thamic lectures.[55] After just two years in the position, Svanberg left for a professorship in general chemistry in Uppsala, but Edlund remained until his death in 1888. Under Edlund's leadership, the instrument collection expanded further, partly because government offices such as the Board of Mines, the Land Survey Board and the Comptrollers' Office, which had now redundant collections, donated them to the Academy. The Institute of Physics also conducted research that gradually generated a relatively sizeable collection of apparatus and preparations, which were both used there and loaned out. Edlund was most interested in electrical phenomena and his best-known work concerned the heat generated by electrical currents.[56] He was also a physicist at the Electrical Telegraph Administration from its establishment in 1853 and for twenty years thereafter.

Erik Edlund was succeeded by Bernhard Hasselberg, who continued Edlund's work, although on a modest scale, until he died in 1922. A clear indication of this was that the Thamic lectures ceased in 1906, to restart for just a few years in the 1930s, with then Permanent Secretary Henning Pleijel in the lectern. What remained was a large collection of instruments and models, listed by Hasselberg in a card catalogue at the end of the 19th century. This turned out to contain more than 800 instruments. At the end of the 1910s, after the Institute of Physics had been shut down, space had to be found for them in the new Museum of Natural History's entomology department and the attic of the Academy of Sciences.[57] A few years after the fate of the Institute of Physics was sealed, Hasselberg also passed away.

THE STORY OF THE ACADEMY OF SCIENCES' instruments and models could have ended here, but the idea arose of using the magnificent collection to create a museum to the history of science, which motivates a detour to the 20th century. The project was run by astronomer and geophysicist Vilhelm Carlheim-Gyllensköld who, when the physics collection was transferred to the Museum of Natural History at Frescati towards the end of the 1910s, and at almost 60 years old, took on the task of organising the Academy's collections and collecting additional instruments to found a museum for the history of the exact sciences. Work on establishing a museum lasted almost two decades, until Carlheim-Gyllensköld's death in 1934, but only resulted in one exhibition. This was reluctantly organised in 1921 by the museum staff, in a room for the mineralogical collection at the Museum of Natural History. This had annual funding of 2,000 kronor from the Academy and some contributions from individuals. Attempts to obtain state funding for the museum and to house it in the Academy of Sciences' observatory on Observatoriekullen, after activities had moved to the newly built observatory in Saltsjöbaden in 1931, were not successful. Instead, the Academy management wanted

Carlheim-Gyllensköld to coordinate his museum project with the museum of technology, Tekniska museet, which was planned by the Academy of Engineering Sciences in the 1920s.[58]

This did not come to fruition and, in 1938, useable instruments were moved to the Nobel Institute for Experimental Physics, which had started its activities a few years previously. The following year, the historical instruments that remained at the Museum of Natural History were squeezed together with the entomology department.[59] In the end, attempts to establish a museum "for the history of the exact sciences" simply led to older instruments, ones no longer viable in research, being separated from the historical instruments that Carlheim-Gyllensköld felt were of a symbolic value and a concrete testimony to efforts to explicate knowledge about natural phenomena.[60] In the 1960s, instruments and models that had become too old-fashioned for research purposes were moved to the Academy's attic, where they appear to have been badly affected by damp and cold. They were later housed at the Academy's Center for History of Science. Some of the historic instruments were used in exhibitions at the Observatory Museum from 1991 to 2014, as described in chapter 3, but not to the extent imagined by Carlheim-Gyllensköld.

HOWEVER, A MUSEUM of scientific instruments was realised by the Academy of Sciences. This was the Berzelius Museum, created through a donation from mineralogist and Academy member Hjalmar Sjögren in 1898, in association with commemorations for the 50th anniversary of Berzelius' death. Chemical preparations, instruments, apparatus and other equipment that Berzelius bequeathed to the Academy were arranged in two rooms on the Academy's premises. In the autumn of 1914, the Berzelius Museum, which had expanded with hundreds of chemical preparations received as gifts from relatives to Berzelius, moved to the new Academy buildings in Frescati, where it could be housed in specially adapted rooms.[61] The Berzelius Museum moved again in the early 1970s, now to an annexe to the Academy building in Frescati. The new museum, which was financed by the Knut and Alice Wallenberg Foundation, opened in 1973; numerous instruments and pieces of apparatus were replaced by text and pictures, and there was an automated slide show. The museum had no regular opening hours, but welcomed visitors after agreement. The Berzelius Museum closed in 2000, although its contents remain.[62]

The natural history collection

The natural history specimens that piled up at the Academy of Sciences were considerably more numerous than the instruments and models. From the very start, a natural history cabinet had been acquired for these samples. This was mounted in Riddarhuset, the House of Nobility, but was soon far too small.[63] A large collection of minerals had arrived in the early 1760s and, in the 1770s, this was joined by a collection comprised largely of insects. In the mid-1780s, the Academy was given a vast herbarium with 16,000 species and, a few years later, a collection of preserved animals from a journey in Africa. And so it continued, with donations and purchases of various kinds. Royalty, such as Adolf Fredrik and Lovisa Ulrika, also contributed.[64] And so the natural history collections grew with astonishing speed, including greater and heavier volumes of minerals. It was no coincidence that explorer Anders Sparrman, who had experience of a circumnavigation with Captain Cook, was employed as the first curator of the natural history cabinet in the 1770s, on secure, if not generous, terms.[65] Sparrman is an indication that staff were now necessary for the management and maintenance of the expanding collections.

However, employing Sparrman to look after the specimens was also linked to how, in 1779, the Academy of Sciences had finally succeeded in buying its own building and no longer needed to move around the city. As we saw in chapter 3, this building was on Stora Nygatan in what is now Stockholm's "old town", Gamla stan. Activities developed; in addition to administration and meetings, a natural history collection was eventually located on the third floor. From September 1786 this was open to the public, free of charge, on Saturdays from 10 am until noon (and then on Wednesdays, from 11 am to 1 pm).[66] This was Sweden's first public museum, even if there are indications that Sparrman did not open it quite as often as he should have.

THE COLLECTIONS WERE IMPORTANT for research, because at this time systematics occupied numerous Swedish biologists. They were organised into classes, but within these there was room for aesthetic factors, symmetries and other principles.[67] Naturally, there was also space for items with entertainment value, such as the "unusually large wasps' nest" built at Drottningholm forty years previously and, appropriately, donated by the queen herself. Other spectacular objects were "an unusual spruce branch", a sugar cane, a "lemon, grown inside another", et cetera.[68] Probably the clearest sign that the borders between science and superstition were still fluid at the end of the 18th century is the donation of a century-old embalmed thumb, which had been chopped off by a Smålandic crofter during a battle with a lake monster that was attempting to drag the crofter's cattle into the water.

And so it continued. Donating a collection to the Academy created status and recognition at the time – and, in the best case, for years to come – for the sometimes life-long efforts required to gather all the objects.[69] Of course, eventually its premises were too small, and there are cases of the Academy of Sciences transferring collections to others, such as in 1788, when Academy member Gustaf von Carlson had to manage all the birds that had been

RECONSTRUCTION OF A THUMB from a supposed lake monster. The original thumb was sent to the Academy in 1752 by Count Gustaf Bonde af Säfstaholm and, according to the records, the thumb was the result of a struggle between a Smålandic crofter and a "Monster Marino" one hundred years previously. The original thumb has not been preserved, but this replica was produced in association with an exhibition that included examples from bygone cabinets of curiosity.

received. This almost ended with it all being for nothing, because von Carlson went bankrupt and his creditors were of the insistent type. Finally, after a claim by the Academy in 1804, a verdict in the Court of Appeal meant that the birds could return to their nest.

ESSAY
Pressing paper peat
p. 400–404

IN THE EARLY 1790S, the Academy of Sciences received a large donation in the form of a library that belonged to the brothers Bengt and Peter Jonas Bergius. This had 5,000 volumes, and there was also a herbarium, which had 15,000 sheets with more than 9,000 species, and their seven-hectare property, Bergielund, south of Karlbergsvägen to the northwest of the city, as described in chapter 3.[70] The orchard was particularly magnificent, with 425 apple trees, 282 plum trees, 152 cherry trees and 32 pear trees, as well as other plants, such as a thousand gooseberry bushes.[71] It is justified to claim that Bergielund was already a superb botanical institution when it came into the Academy's ownership in 1791, even if it was a private one.[72] However, its activities were primarily focused on the cultivation of fruit and berries, both experimental and for sale. The Academy of Sciences soon founded the Bergius Botanic Garden, which was led by a Bergianus professor and a head gardener.

Within a few decades, the now extensive botanical collection was expanded with a zoological one. This had been donated in 1819, by Gustaf von Paykull, a squire from Uppland whose work in entomology had led to membership of the Academy.[73] The idea was that the collection, which primarily included insects and mounted birds, but also had a camel, a zebra and a water buffalo,

GUNNAR BRUSEWITZ' DEPICTION of how Gustaf von Paykull's natural history collection was transported from the manor at Wallox-Säby, outside Uppsala, to the Academy of Sciences in Stockholm. The Paykull donation of 1819, which was the foundation of the Swedish Museum of Natural History, included almost nine thousand species of insects, far more than one thousand boxes of birds, a range of mammals and vast amounts of preserved fish.

would be the foundation of a state-run natural history museum. The Academy of Sciences was tasked with investigating how this could be organised.[74] The Paykull donation alone had 80 mammals, presumably stuffed, and 1,362 boxes of birds, also hopefully preserved in some way, as well as eight boxes of insects. The transport of large stuffed animals from Uppsala to Stockholm took three steam boats and demonstrates the lengths the Academy was willing to go to expand its collections.[75] Because the Academy took on the Paykull collection and created a national zoological museum, it received some state funding from 1820. A few years later, Adolf Ulrik Grill also donated a collection containing another 80 mammals and 700 birds.[76] Initially, the Academy optimistically claimed that the collections would fit in the existing premises on Stora Nygatan, where they were soon displayed, while their curator was comforted with a well-deserved professorship in 1823.

IT IS HARDLY SURPRISING that, just five years later, the Academy capitulated and was more than happy to move from the now under-dimensioned building on Stora Nygatan described in chapter 3. Still, the Paykull and Grill donations were not the only ones to reduce the capacity of the Schönfeldt Palace. At the start of the 1820s, numerous fossils were accepted, but especially insects – including two boxes from Brazil that were bought at auction and 16 donations from Sweden. In addition, there was a white squirrel from Östergötland and a six-footed frog of unknown origin, along with a great deal else that was stuffed, nailed, glued, pressed, dried or preserved in alcohol. It is also worth mentioning the Mexican sea urchins that were donated by a wholesaler.[77] Finally, as a replacement, a building was purchased that was considerably more spacious than the one in Gamla stan. Here, it was easier to display the various collections to the public, who were welcomed to the new Swedish Museum of Natural History in 1831.

The issue was not only the somewhat systematic display of the collections for informing the public about natural order and mankind's control over it, nor the attempt to recreate a paradisiacal original state through a museum. The entertainment value was also considerable and could be converted to money, particularly when the museum was offered a giraffe from Africa in the 1830s. The curator's calculations showed that costs should be quickly recuperated through the expected crowds.[78]

The museum's activities then expanded in stages. In the 1840s, more curators were employed and activities were expanded with botany and mineralogy, among others. Public funding increased at the same time, and the Academy of Sciences' collections pretty much merged with the state's, so that from 1849 they were all regarded as state property. Soon it was time to extend the current premises, which was done using state funding in the 1850s and 1860s, so that a larger – primarily zoological – museum was able to open in 1866.[79]

One disadvantage for the Museum of Natural History and its ability to acquire exotic, and thus crowd-pleasing, natural history specimens, was the lack of Swedish colonies on foreign continents. These circumstances were at least partially compensated for by the Linnaean heritage of comprehensive expeditions and research travel with the industrious collection of mineral and plants specimens, as well as insects, birds, reptiles and mammals. Throughout the 19th century, the museum accepted material from various such expeditions and the collections expanded in different directions, partly depending on the routes taken by the expeditions. For example, in the 1880s there was more paleontological material as a result of the polar expeditions.[80]

ESSAY
Travelled territories
p. 544–548

The library and other collections

If a fungus was the foundation of the Academy of Sciences' natural history collection, as described in the previous chapter, the first book in what would eventually be the Academy's library was *Hortus Cliffortianus* (1737), donated by its author, and Academy founder, Linnaeus.[81] Initially, the library mainly grew through book donations and purchases. In 1749, the Academy of Sciences began to exchange texts with other scientific academies, with the Royal Society in London as its first partner. Eventually, a library was built up and housed in the observatory. The first catalogue was compiled in 1768 and contained 2,300 items. Growth continued over the following decades, still through donations and purchases, especially from estates of the deceased.[82] When the Academy moved to its new building in Gamla stan in 1779, the library was also relocated. Only its astronomical and mathematical sections remained at the observatory.[83] An unusually large and valuable addition was a donation of 3,000 volumes of older Swedish works in the year after the move, 1780. The library was very important to the Academy's own publishing activities, as was evidenced via a large deposit made by the King in Council in 1806, which contained books that were expected to be beneficial sources of information when the Academy of Sciences started to publish *Economiska Annaler* [*Economic Annals*] the following year. The annals were initially published according to plan and, one can assume, with the help of the library donation. However, the project was put on hold after just two years.[84]

In association with the Bergius donation in 1791, as stated, the Academy of Sciences received the Bergius brothers' library of no less than 5,340 volumes, which was equivalent to about 200 shelf metres.[85] This included one of Sweden's foremost collections of botanical works from the 16th to the 18th century, along with medical, zoological, geographical and historical literature.[86] In accordance with the will, the Bergius Library remained intact and remained at Bergielund until 1831, when it was moved to the Academy library in the newly opened premises on Drottninggatan. The fact was that, more than 150 years later, years that were filled with a stream of donations and purchases, the Bergius Library remained the jewel in the crown of the Academy of Sciences' book collection.[87]

While the Bergius Library was a welcome addition in the first decades of the 19th century, it became increasingly difficult to acquire up-to-date scientific publications in Sweden. The charges for book packages were astronomical, often many times higher than the contents were worth. Stockholm's bookshops were acknowledged to be in a terrible state and the government was also doing what it could to prevent outside influence. These were troubled times: Napoleon was overwhelming the continent and trade barriers were an established cure-all in economic policy. It was in these difficult circumstances that the Academy of Sciences was trying to maintain exchanges and journal subscriptions. Thankfully, the Academy enjoyed the government's blessing and had been exempted from postal charges since the 1740s. We can assume that the newspaper room at Stora Nygatan was well-visited when it was open to members on Wednesdays and Saturdays from 9 am to 1 pm and 2 to 4 pm.[88]

From 1810 to 1867, the influx of scholarly literature from Britain and the continent was balanced by a new regulation that meant the library of the Academy of Sciences and the former National Library should have a copy of everything newly published by Swedish presses.[89] Naturally, from the Academy's perspective, this was not as relevant as better access to scientific literature from abroad. Yet what was worse was that it meant the library expanded even faster than ever before.

AS REGARDS THE STAFFING of the library and archive collections, until 1820 the secretary of the Academy was also its librarian. Berzelius then ensured that the position of librarian was established; this also included curating the Academy's zoological museum, which eventually became part of the Museum of Natural History. As the library continued to grow, the position was divided and a dedicated librarian was appointed in 1831, the same year the Bergius Library was merged with the other book collections at the Academy of Sciences.[90] Staff resources were further expanded at the start of the 1840s, with the addition of an assistant.[91]

And so the expansion of the library continued throughout the 19th century. The necessity of scientific literature was not least demonstrated by the way that the annual overviews, published by the Academy from 1844 onwards, listed all the library's new acquisitions. Towards the end of the century, the book collection had grown so much it was the most important natural science library in Scandinavia. Expansion continued in the "book tower", specially designed in the new building in Frescati to house the library. However, everything finally ended in the 1960s, when various inquiries examined potential cooperation between the Academy of Sciences' library and other libraries for medicine, technology and the natural sciences in Stockholm, as part of the general review of Academy activities on the revoking of the almanac privilege.[92]

HOWEVER, BOOKS WERE NOT THE ONLY THINGS piling up in the cupboards and shelves of the Academy of Sciences. At the same time as the Bergius donation, the Academy of Sciences received the Bergius transcript collection of around 5,500 copied letters, including ones to the secretary of the Academy. This collection, with 20 heavy volumes, also includes transcripts of documents that were not published when the collection was founded and for which the original has been lost.[93] Even before the Bergius transcript collection came to the Academy, and more so later, the Academy of Sciences managed a number of relatively large collections of letters from famous Swedish scientists. There were several collections of letters from secretaries of the Academy, from Elvius and Wargentin to Berzelius and Sjöstén. But the directors of the various departments of the Museum of Natural History were also obliged to transfer their letter collections to the Academy when they were no longer needed at the museum.[94]

In addition, there were collections of maps and photographs of varying kinds. The portrait collection of the Academy of Sciences is particularly interesting. The first portrait was of Polhem; this was donated to the Academy in 1753 when, appropriately enough, it was hung in the newly inaugurated observatory. Over the years, this collection has become relatively substantial, and now contains over 200 painted portraits of Swedish and foreign scientists, primarily members. In addition to the paintings there are almost 80 bas relief plaques in plaster, wax or less noble alloys such as bronze, as well as 61 busts and statues in plaster, bronze or marble.[95] There is also an extensive collection of reproduced portraits, with around 2,000 sheets of etchings, lithographs, et cetera, as well as a photograph collection from the latter part of the 19th century, with original photographs and photographic reproductions of portrait paintings and etchings of scientists. The photograph collection grew throughout the 20th century, with new original photographs. If we also include the photographs and pictures in books and journals, by the end of the 1950 the Academy of Sciences had portraits of no fewer than 15,000 people.[96]

ESSAY
Collecting scientists
p. 570–575

WHY THIS OBSESSION WITH PORTRAITS? Are Academy members especially beautiful? Do they have a greater need to eternalise their faces than other people? The question is partly related to art history and partly to portraiture in general; the answers relate equally to artistic interest in a person's features and to the genre conventions of art, where portraiture has often been dominant. Certainly, artistic activity as a driver of status for both the artist and the sitter is also equally important. As photographic technology became cheaper and more common in the second half of the 19th century, photo collections also grew, not least portrait photography. One such collection that is included in the photographs of the Academy of Sciences is that of the

Academy physicist Bernhard Hasselberg. This dates from the first decades of the 20th century, and includes portraits from science history as well as original contemporary photographs. Perhaps the interest here was due to a combination of the availability of photographic technology and a desire, in the era of a professionalised society, to define the people who can historically be said to have represented the early natural sciences, rather than other, more dubious, activities such as astrology or alchemy.[97]

Still, there may also be an explanation that includes portraits of scientists at the end of the 19th century and in the early 20th century, namely ideas about human traits being externally visible in some way. Various types of racial theories are of course well-known, but there is also physiognomy, the idea that an individual's inner character and abilities are reflected in their appearance.[98] At the time when these ideas were of interest, this form of physical anthropology resulted in extensive collections of portrait photographs of individuals and groups from many regions, often with a derogatory element. Physical characteristics were measured and systematised to provide data about the differences between groups of peoples.[99] Academy members Anders and Gustaf Retzius, father and son, were leaders in this area of research, along with others who had strong links to the Academy of Sciences.[100] From this perspective, it is perhaps not so surprising that notice was also paid to what some Academy members may well have regarded as the other end of the spectrum.[101] It is possible that the way the interest in portraits of scientists should be understood is as an attempt to gather material for a synthesis of external features, ones that reveal the various characteristics of leading scientists, what differentiated them and what they may have had in common.[102]

NOWADAYS, THE MEDALS AND COINS struck by the Academy of Sciences, primarily to commemorate leading but deceased members, seem even more idiosyncratic than the large collections of portrait photographs. Commemorative coins and medals were often awarded to members and dignitaries at Annual Meetings and in other, somewhat formal, contexts. They could also be used as rewards for particularly deserving contributions or as encouragement in various situations.[103]

The first medal from the Academy of Sciences was struck to honour Crown Prince Adolf Fredrik, when he became the patron of the Academy in 1747. Over the next fifty years, the Academy became Sweden's single largest issuer of commemorative medals, representing one-fourth of all medals in Sweden in the second half of the 18th century. This is potentially quite reasonable, bearing in mind that scientists, alongside merchants, were the biggest category of non-nobles of the estates who were commemorated with medals in the 18th century.[104] The Academy of Sciences continued its frequent representation among medal issuers in the 19th century – almost thirty were struck between 1800 and 1849. In total, there were in excess of a hundred medals in just over a century, with the only decline at the start of the 19th century, which is generally regarded as a low point for the Academy of Sciences.[105] This tradition of striking medals to leading, but deceased, members was also maintained later.

The design of the medals was a not uncontroversial subject. As the members of the early-modern academies were of relatively equal status, these assemblies were an interesting alternative to the older, traditional hierarchy of the estates that otherwise reigned, which made an impression on the design of the medals, amongst other things. The design on the rear of the medal issued by the Academy of Sciences to commemorate Wargentin in 1783 particularly deviated from the then-ideal allegorical style. It depicted Jupiter's moons in their position on Wargentin's death, an image associated with astronomical expertise instead of classical education, as an allegorical image would have.[106] There was also a "utilistic" side to this, taking into account economic benefit, because observations of Jupiter's moons related more to cartography than to astronomy, at least according to Wargentin himself; tables of the moons' movements could be used to determine locations.[107] The front of the medal alluded to specific achievements by Wargentin in the field of astronomy, as he was famous for his painstaking calculations of the orbits of Jupiter's moons, rather than for any general virtue or ancestral worthiness.[108]

The Academy and scientific travel

At the same time as the Academy of Sciences was establishing its collections and catalogues as a form of science, manifested through its various more or less public collections, as well as in more technically-focused experimentation expressed through public lectures, the scope of travel as a third form of knowledge at the Academy also grew from the 1810s. The Academy of Sciences had awarded travels stipends and made contributions to expeditions before then, not least for measuring meridian arcs, but this type of support for scientific travel first became more regular in the 1810s, in particular because of an 1808 donation to be used abroad in the applied sciences, and another donation in 1815 that was earmarked for scientific travel within Sweden.[109]

Following the reorganisation of 1820, interest at the Academy grew in scientific expeditions as a form of knowledge, as the informal class of 15 to 20 corresponding members, established five years previously, was dissolved due to a lack of success.[110] In 1820, the new statutes of the Academy of Sciences included wording about how the Academy should particularly support domestic travel for the investigation of botany, zoology, geonomy, mineralogy and geography. The disciplines were all listed with potential applications, and had previously been highlighted by botanist Olof Swartz in his position as the secretary before Berzelius. This was nothing other than the codification of the early 19th-century practice of contributing to domestic travel for scientific purposes.[111] The difference now was that this support had the character of a fixed travel stipend, whereas temporary solutions had once been necessary to obtain financing. The reason for journeys within Sweden rather than abroad, which had previously been common, was associated with the loss of Finland to Russia in 1809 and the interest in "to once again conquer Finland midst Sweden's borders" as Esaias Tegnér formulated it in 1811.[112] Because doubles could be used for trading with other natural history collections, there was still a value in new, rare items even after a collection was complete. This was one of the reasons why expeditions often went a long way north.[113]

While, in the 1820s, journeys under the auspices of the Academy of Sciences were primarily concerned with botany, in the 1830s they instead concentrated on zoology. Norway also became an increasingly important area of investigation, both as a result of the union in 1814 and as a consequence of Sweden being increasingly investigated and explored. Naturally, all expeditions led to the expansion and improvement of the collections of the Swedish Museum of Natural History. This was particularly true of zoology in the 19th century, because botany had already been relatively well-supplied in the previous century. Additionally, zoological exhibition items were more expensive and difficult to collect than botanical specimens, a circumstance confirmed by the lack of private zoological collections of any great significance, and so a public museum such as the Museum of Natural History could therefore be regarded as having special responsibility for zoological collections. There were also various areas of application, such as better understanding the migration and distribution of fish species in the Nordic region.[114] There is no doubt that, a century after it was founded, weakened forms of patriotism and "utilism", the 18th-century ideological stance stressing the utility of knowledge, remained among the ideological mainstays of the Academy of Sciences.

The expansions to the zoological collections had repercussions on activities at the Museum of Natural History when it relocated at the end of the 1820s. The museum's new zoology curator felt that a public collection should not simply display "frippery", but should primarily promote the sciences.[115] However, the collections should be displayed in an educational manner. For example, visitors should first see collections of lower animals, such as corals and gastropods, and then come to the insect collections, and so on. Another principle was that of grouping together Scandinavian fauna, probably for both ideological and zoogeographic reasons.[116]

AT THE SAME TIME AS the Academy of Sciences was becoming something of a supporting organisation for public natural science in Stockholm in the 19th century, it was reinforcing its position as a source of funding for scientific travel and expeditions to distant places. These parallel processes were in no way contrary to each other. Quite the opposite, travel contributed to the collections that were exhibited in the capital and which, in turn, provided motivation for new expeditions.

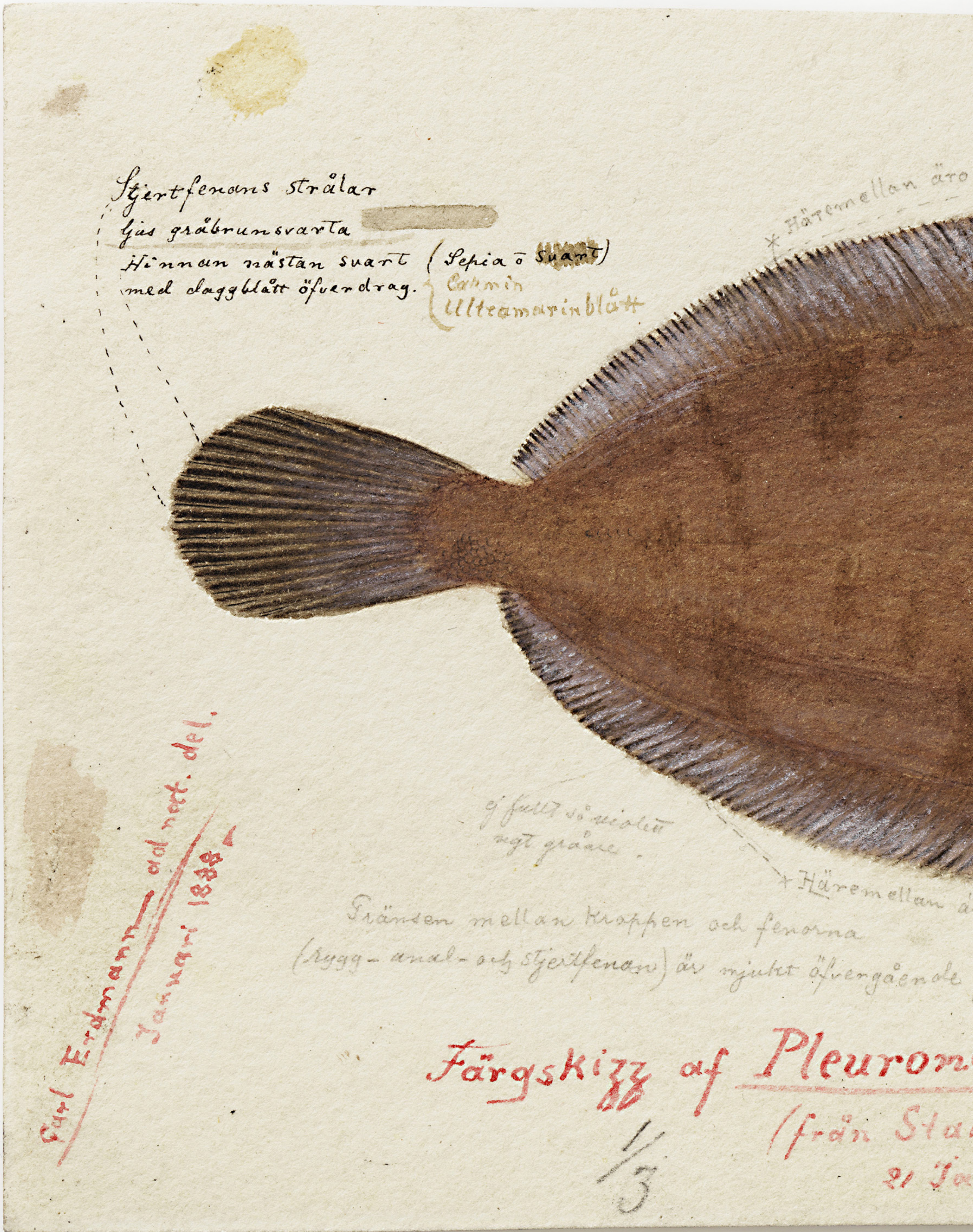
ESSAY
The patchwork panorama
p. 453–459

For example, in the spring of 1835, a four-man expedition travelled to Bohuslän; this was led by Bengt Fries, zoology professor and curator at the Museum of Natural History. They installed themselves at the Kristineberg estate on Gullmarsfjorden, to make minor forays along the west coast. The point was to avoid travelling between fishing villages with the vast amount of apparatus and instruments that were necessary for research and preservation. Kristineberg was suitable because of its location and the availability of "helpmeets".[117] In addition, the high salinity of Gullmarsfjorden meant it had Sweden's most species-rich marine fauna; it was not only the skilled use of the dredger that allowed the expedition to retrieve and take home an unusually rich harvest of bottom-dwelling small creatures.

However, once the creatures had been caught, they had to be preserved in a way that did not change their appearance too greatly. This was a well-known problem, leading to criticism about the collection of species by removing them from their habitat. It was often necessary to append notes to preserved specimens to specify the species' characteristics. The consequence could otherwise be erroneous identification, something best counteracted by taxonomists examining living creatures on site. However, preservation techniques continually improved, such as in 1838, when Fries announced that he had succeeded in preserving jellyfish, apart from their colour, without them entirely disintegrating.[118]

There is no doubt that the Academy of Sciences' position as a provider of funding and support for various scientific travel projects also entailed it following changes in scientific fashion. Major scientific expeditions to foreign countries were, as we have seen, nothing new; these had taken place for several centuries. However, the scientific travel of the 19th century brought something new. It was often on a larger scale, with greater systematics, and was also more thoroughly documented than previously. Even if scientists still

SKETCH OF A FLOUNDER (*Pleuronectes cynoglossus*) by Carl Erdmann, 1888. He had studied at the Academy of Fine arts and then specialised in nature drawings. The illustration was later included in Wilhelm von Wright's *Skandinaviens fiskar* (1892–1895). The notes are instructions to the printer about colour reproduction. ►


Stjertfenans strålar
göras gråbrunsvarta
Hinnan nästan svart (Sepia o svart)
med daggblått öfverdrag. Carmin Ultramarinblått
Häremellan äro
ej fullt så violett
något gråare
Häremellan ä
Gränsen mellan kroppen och fenorna
(rygg- anal- och stjertfenan) är mjukt öfvergående
Färgskizz af Pleuron
(från Sta
21 Ja
1/3
Carl Erdmann ad nat. del.
Januari 1888.


strålarne hvitgula i spetsen somliga brunhvita
Strålarne i bröstfenan blekt violetta (daggblå)
so strålarne hvitgula, (brunhvita i spetsen
(ej skarpt)
ectes Cynoglossus.
hrekil, Strömstad.
nuari 1888. C.A.Hansson.

had to travel on trading ships for longer voyages, with everything that entailed in terms of limited resources, they appear to have approached unknown territory with an eye for the overall view and not primarily for the sake of individual species and specimens.[119] This was the time when plant geography and animal geography, for example, were introduced as new scientific disciplines.

For this, scientists needed help from the local population and amateurs who often knew considerably more about the conditions for flora and fauna in a particular place. Expeditions thus used local knowledge in establishing new insights, which were printed in various scientific publications. These journeys became an important link in a circulation of knowledge from the local to the central, where the double roles of the Academy of Sciences – as a central scientific institute in the capital and financier of travels outside it – became an indispensable force.

The Academy and the growing bureaucratic state

In the second half of the 19th century, the state expanded and intervened more in what had formerly been private areas, such as trade policy. In knowledge policy, general elementary school education was introduced in 1842, first as a municipal concern but with increasing state involvement. In the second half of the 19th century and the first few decades of the 20th century, this used up a growing share of the expanding state budget. Meanwhile, the universities also saw more of their costs covered by state funding, which meant they could grow beyond the conditions previously dictated by land donations – agricultural properties where returns from the land were to finance activities.[120]

At the same time, a number of infrastructure systems were built by the state. National systems for transport and communication had consisted of inns and the postal service since before the Academy of Sciences was founded.[121] In the 19th century, transport and communication capacity increased considerably, first with canals and later the railway. With the arrival of the railway, state investments in the main lines were considerable. Initially, the idea had been to extend the main lines privately, with state interest guarantees, but when investments did not produce the expected returns in the 1840s – due to a British financial crisis in 1846 – the government initiated an inquiry. This led to a proposal that the state should build main lines using foreign loans and that private stakeholders could then build local lines from the main lines. This received the support of the 1856/1858 Riksdag, despite tough opposition. Finance minister Johan August Gripenstedt's 1857 defence for taking foreign loans for investments in the railway has gone down in history, as has his motivation that the railway's importance for economic growth was greater than its cost. The following year, Gripenstedt was elected a member of the Academy of Sciences. The western main line between Stockholm and Gothenburg opened in November 1862, with the southern one to Malmö opening two years later.[122]

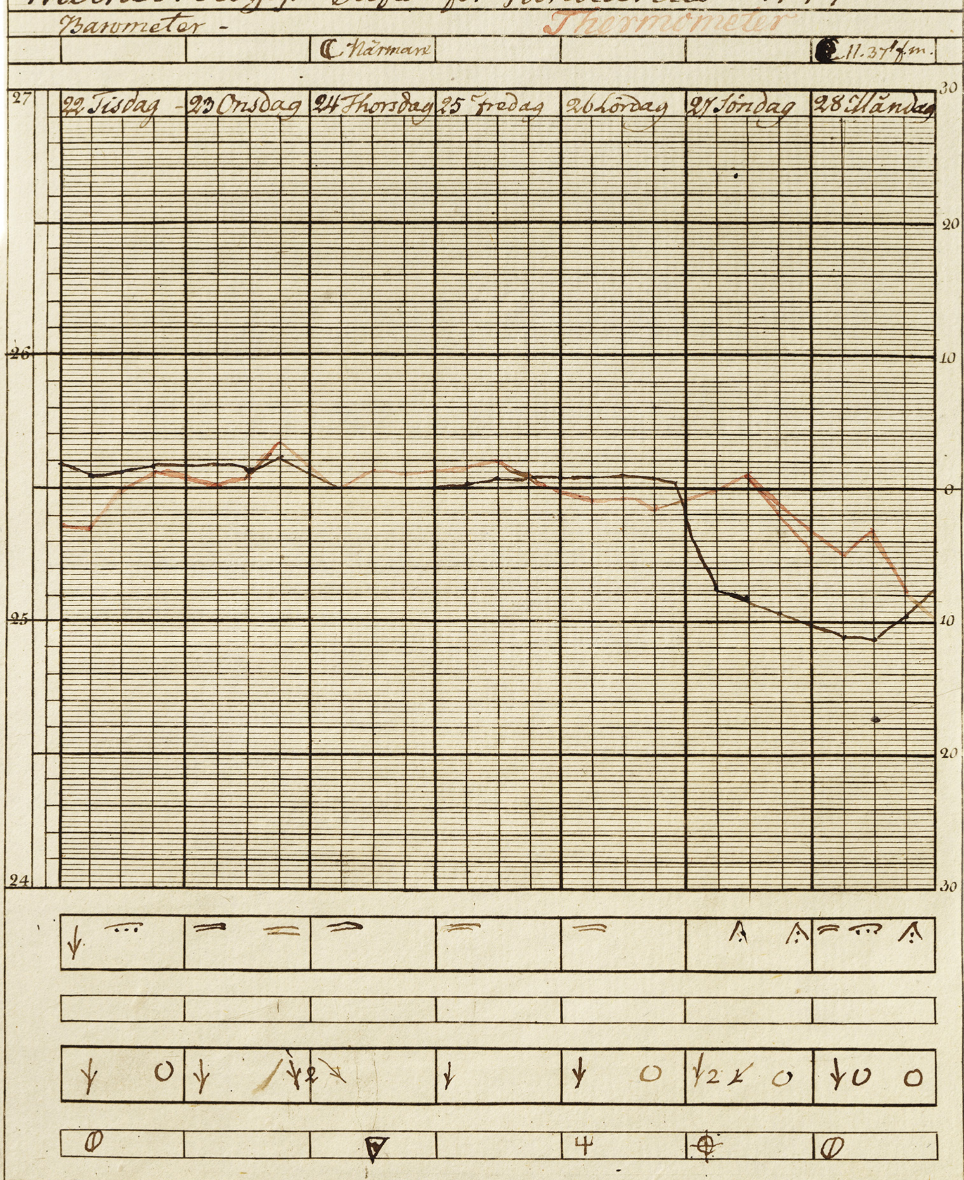
ANOTHER MEMBER OF THE ACADEMY, general Carl Fredrik Akrell, had already been influential in the expansion of a state telegraph network in the 1850s. Akrell was head of the topography corps that was responsible for the optical telegraph system in the archipelagos of Stockholm, Gothenburg and Karlskrona from the 1790s. Sweden was actually the second country, after France, to establish an optical telegraph network, although the Swedish system used semaphore arms instead of the French system's shutters. When, in the 1830s, it became possible to send electrical telegraphs, cable systems were built up and, in 1852, the Swedish government tasked Akrell with producing a plan for electrical telegraphs in Sweden for military, political and economic purposes. Expansion was rapid and a line opened between Stockholm and Uppsala, about a hundred kilometres to the north, as early as 1853. A line to Skåne, 600 kilometres to the south, was completed in the summer of 1854 and, later that year, an underwater cable was laid in The Sound, connecting the Swedish network to that of the continent.[123]

As we have seen, transport and communication systems expanded hugely in the mid-19th century. This came to have consequences for the Academy of Sciences. As transport became easier and cheaper, it was simpler to establish permanent research stations in places beyond the most frequented routes. And, thanks to improved communication systems, observations in different parts of the country, of the weather for example, could be compiled more rapidly and thereby used to analyse patterns of changes in a way that had not previously been possible.

Central office and marine station

After the first telegraph cables were laid, it did not take long for the Academy of Sciences' physicist, Erik Edlund, who was also a physicist at the Telegraph Administration, to propose that meteorological observations should also be performed in Sweden. The Academy had a tradition to fall back on, because the weather had been recorded since the observatory was founded in the 1750s, and even earlier than this, as described in the previous chapter. In addition, the telegraph network had grown so considerably by the mid-19th century that it had the potential to be an invaluable asset in establishing an international meteorology cooperation. Naturally, Edlund saw the connection, which became clear to everyone when France initiated an international exchange of weather bulletins in the 1850s.[124]

Metheorologisk Tafla för Januarius 1799.



D:25 Jan. kl:4 f.m. vid sydlig vind och klar luft, kändes flera och starka skakningar af Jordbäfning ifrån kl:3.45' i Rouen kl.4.5' i Laval och kl.4.15' i Nantes, skakningarne varade i 25 minut. i la Fleche i sättle departementet, och flera skorstenar ramlade, sträckningen var således N.O.t.O. ~~mot~~ til S.W.t.W.

Led by Edlund, the Academy now established weather stations throughout Sweden and, by the end of the 1850s, there were 24 active stations funded by the state.[125] In the 1860s, these were linked to the international telegraph network, and reports were telegraphed daily from Stockholm, Härnösand and Haparanda. Telegraph stations that were equipped with a weather station were purposely used; they were practical, because they were already staffed and equipped with a clock, which meant readings could be taken at fixed times.[126] The system was not called telegraphic meteorology for nothing, an indication that the circulation of knowledge could now use new technology to become more effective and more coordinated.[127] If there was no suitable telegraph station, a school teacher or other interested person was engaged.[128] The position of meteorology in Sweden was strengthened by daily meteorological observations at Uppsala University's new observatory from 1865. Further inspiration came from abroad in 1870, when a Swedish report on European meteorology was published. It is probably no coincidence that it was at precisely this time, 1869, that weather predictions disappeared from the Academy of Sciences' almanacs.

ESSAY
Kites and balloons
p. 448–452

The author of the report, Hugo Hildebrandsson, a meteorologist in Uppsala, proposed a Swedish meteorological institute financed by the state. He claimed that the costs would be covered by a single storm warning that saved just a few ships, or a frost warning that meant that as yet undestroyed crops could be harvested in time. The Academy of Sciences made the proposal its own in December 1871, launching the idea of a state-financed central meteorological station for a system of rapporteurs, located at geographically spread weather stations, all organised by the Academy. Employees would not only make weather forecasts, they would also collect weather data to calculate the laws of atmospheric movement. The proposal found favour in the Riksdag where, for safety's sake, it was supported by Erik Edlund in his capacity as member of parliament in the Second Chamber, in 1872. The result was funding from the Riksdag for a central meteorological office which, from 1873, gathered weather information from around forty weather stations throughout Sweden. Barely twenty years later, this number had increased to 450.[129]

Throughout the 1870s, rural economy and agricultural societies were also used for weather observations throughout Sweden, and the Academy ensured that private individuals regularly contributed to the weather information

WEATHER OBSERVATIONS from Gothenburg for a week in January 1799. A note from 25 January states that an earthquake occurred. The document is part of an extensive collection of weather observations recorded in the city from the end of the 18th century and many years into the next century. It is unclear who made the observations.

being communicated to the central office. The observations were eventually systematised so much that they could form the basis of somewhat more reliable weather forecasts. In fact, no forecasts had been made at all prior to 1880, despite this being an important argument for the founding of the central office. In any case, in the 1890s, the use of weather maps expanded because they could include up-to-date meteorological information, which was telegraphed to a number of stations every afternoon. This service was particularly intended for farmers. The Central Meteorological Office was a research institute that reported to the Academy, until it was reorganised in 1919 and merged with the National Hydrographic Office and the Nautical-Meteorological Bureau. The director of the central office, Nils Ekholm, rejected the merger – he wanted to remain under the auspices of the Academy – but now there were no longer any Academy members in the Riksdag who could convince the others to leave everything as it was. The central office was thus disbudded from the Academy of Sciences to be subsumed into the newly founded State Department for Meteorology and Hydrology. At the same time, aged 70, Ekholm retired.[130]

IN PARALLEL WITH THE GROWTH of the Central Meteorological Office, one of the most important research institutes of the Academy of Sciences was founded – the Kristineberg Zoological Station. This was created in 1877, using a donation that aimed at establishing a zoological research station on the Swedish west coast.[131] Naturally, it was no coincidence that it was located at Kristineberg, by Fiskebäckskil on the island of Skaftö, across the water from Lysekil, on the mouth of Gullmarsfjorden. As previously described, the professor of zoology and curator at the Swedish Museum of Natural History, Bengt Fries, had identified the rich marine fauna at the mouth of the fjord during his expedition in 1835. He returned and, in 1839, he was accompanied by a colleague from the museum, Sven Lovén, who, with his interest in Echinodermata, particularly sea urchins, established a research tradition in the fjord.

In the early 1840s, Sven Lovén succeeded Fries as professor and curator of the Museum of Natural History's invertebrate department and, in this position, was able to further his interests in Sweden's trilobites and marine molluscs. In the following decades he returned to Kristineberg many times, also noting how Fries' contacts with local residents made work easier. Actually, said Lovén, people from the district had an inherent curiosity about various marine species.[132]

Using the donation, a property was acquired in Kristineberg in 1877, eased by the way that property prices there had not yet increased as dramatically as in other places along the increasingly exploited west coast.[133] The station grew fairly rapidly, with a laboratory, accommodation, pumphouse and reservoirs, and was finished in 1885. During the summer, the laboratory contained one small and two large aquariums and running saltwater.[134] There was also a research vessel that could be used for collecting samples. Marine life in Gullmarsfjorden was the primary focus of study, but there were also excursions to Kattegat and Skagerrak. Zoology was no longer the sole specialisation; over time, zoogeography and ecology with studies of invertebrate populations became particularly important. Research on algae also began at an early stage.

The director of Kristineberg remained the curator of the Museum of Natural History's invertebrate department. Apart from scientific staff, the station also had a caretaker, a captain and a housekeeper from a family that lived in Kristineberg before it became a research station. In addition, there were two hourly-paid dredgers and other staff with local knowledge. Sofia Kristensson, the housekeeper, was vital to work at the station during the long winters when there were no biologists on site. She received orders for species and forwarded them to fishermen, received the samples that were captured and sent them to Stockholm or other places where marine biologists opened with excitement the packages that flowed in. Fishermen sometimes made spontaneous deliveries of species that they assumed could be of interest. There was something of a trade in specimens that fastened in the nets and would previously have simply been thrown back in the water.[135]

However, in the summers, the majority of the station's staff were researchers from Swedish universities, teachers, and the occasional foreign visiting researcher, as well as the more advanced students selected by Lovén. There were fifteen or so researchers who, every year from the start of the 1890s, could use the marine station's research facilities even during the winter, because the station started to remain open all year. In the early 20th century, a winter laboratory was built using a donation of 40,000 kronor, which meant that the number of researchers almost doubled after 1906.[136] Additional donations allowed the boat fleet to be expanded and the two jetties to be replaced by a more standard harbour.

The Central Meteorological Office and Kristineberg Zoological Station are both examples of institutions created for research and testing in areas that were considered of particular interest for societal benefit. In the latter half of the 19th century and early 20th century, a great number of similar institutions would be founded in many areas, from forestry research to materials testing. In many cases, the intention was to provide the right conditions for knowledge to come to practical use in particularly pressing areas. Creating these knowledge organisations that were to function as bridges between researchers and the purchasers of knowledge in industry or agriculture, for example, was not a Swedish idea; it was a European organisational pattern that was also used in Sweden.[137] This makes it possible to talk about institutional uniformity across national borders. Some of these research institutions were founded on state initiatives, others on the initiative of industrial organisations or other societal stakeholders. They often utilised both public funding and funding provided by the most involved purchasers, and were frequently established by sector organisations or stakeholder groups. As we have seen, the Academy of Sciences was involved in a few cases, but far from all.

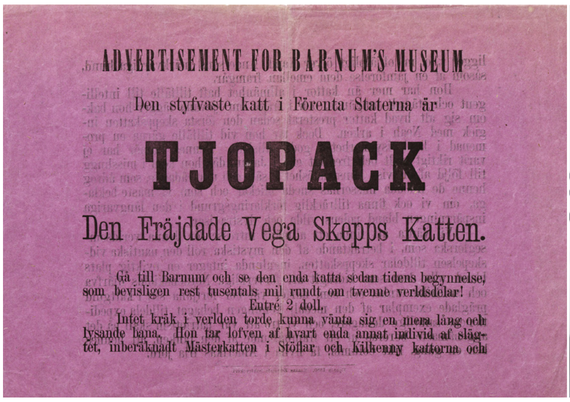
Polar expeditions

ESSAY
The Santa scientist
p. 428–432

In parallel with stationary scientific research, there were also more ambulatory projects out in the field. The various domestic and foreign expeditions à la Linnaeus have already been covered and, as stated, they often went northward, not least to hunt for rare flora and fauna. One such voyage was made by the Linnaeus apostle Anton Rolandsson Martin, who, aided by a stipend from the Academy of Sciences, was able to travel on a ship to Spitsbergen in 1758. It was sailed by the first Greenland company in Gothenburg, which had received a monopoly on whaling and the production of seal oil in 1755. Unfortunately, Martin was unable to land very often, so his observations were mainly made from deck. He did, however, subsequently receive a financial gift from the Academy for the meteorological observations he submitted on the Arctic Ocean.[138] Although another Greenland company was founded in Gothenburg in 1774, it would be almost eighty years until the next Swedish scientific voyage to Spitsbergen was made by Sven Lovén in 1837.

FROM THE 1840S ONWARD, interest moved even further northward and polar expeditions became increasingly popular internationally. This was driven by nationalistic ideologies that provided reasons to conquer the northern regions of the world, just as much as economic-geopolitical ambitions were a basis for surveys ahead of exploitation. Naturally, scientific motivations were still an important ingredient, but the drive for discovery and enthusiasm for the wilderness led to a more general passion for the polar regions.[139] Together, these four components formed an almost inextricable system of ideas – an ideology – that motivated numerous Swedish polar expeditions, many of them run by the Academy of Sciences. Some of the most famous polar explorers had their institutional base at the Museum of Natural History.[140]

The best-known Swedish polar expedition, called the Vega expedition after its ship, was led by geologist and mineralogist Adolf Erik Nordenskiöld, who had been made professor at the mineralogy department of the Museum of Natural History in 1858 and, three years later, elected as a member of the Academy of Sciences. Nordenskiöld gained great experience of polar travel in the 1860s and 1870s. For example, between 1858 and 1873 he participated in five scientific voyages to Spitsbergen, leading three of them. The first ones,



ANIMALS WERE CREW MEMBERS onboard scientific expeditions at sea. Ship's cat Tjopack found fame after serving on *Vega*. He (or a relative) was displayed by Barnum's Museum on a tour of Sweden in 1880. Of lesser fame was the cat that sailed with Alfred Gabriel Nathorst's vessel to Svalbard in 1898, where activities included hunting polar bears.

in 1858 and 1861, were led by geologist and marine biologist Otto Torell who, thanks to a sizeable inheritance and good contacts with the Academy of Sciences, was able to equip the expeditions to study the effects of active glaciers on geology. This meant he was able to draw conclusions about Scandinavian ice sheets, which were a controversial issue at the time.[141] In 1870, he led an expedition to study the Greenland ice sheet, and in 1875 and 1876 he led another two expeditions that sailed to Siberia.

One project that absolutely captured the late 19th-century interest in the polar regions was the one launched by Nordenskiöld in 1870, along with naval officer Fredrik von Otter and the major patron of every polar expedition: industrialist and native son of Gothenburg, Oscar Dickson. Its background was a find of tricalcium phosphate, discovered by Nordenskiöld on Spitsbergen six years previously. At this period, phosphates were becoming an important ingredient in the fertilizers used on farmland. The idea was to exploit the find on behalf of Sweden. The only problem was that Spitsbergen was *terra nullius*, an area of land under no national jurisdiction and where there were thus no legal opportunities to make claims on various kinds of finds.

In order to exploit the phosphate find on Spitsbergen without any risk of other investors piggy-backing on the project, in the autumn of 1870 Nordenskiöld approached the Swedish government with a proposal that Sweden should occupy Spitsbergen. The idea was to establish a colony next to the phosphate find for scientific and economic reasons. People from the

ESSAY
Northern lights, paper and pencil
p. 442–447

CLAY CORE SAMPLES from the observatory in Cape Thordsen during an expedition to Spitsbergen in 1882.

north of Norway, then in a union with Sweden, could settle here to live off hunting and fishing, and mine phosphate during the winter. The mineral would be shipped out during the ice-free summer months. The idea was also to establish a measurement station for daily meteorological and geomagnetic observations, throughout the year, and for the regular study of the northern lights. At this time there was no scientific station at such a high latitude anywhere in the world, and it was therefore of great scientific interest.[142]

However, the government was unwilling to become involved in such an enterprise. Instead, it sent the plan to the Norwegian government which, in turn, chose to take no action; in this situation, it was still the Swedish government that had to communicate with the relevant countries to inquire whether there were any objections to Sweden-Norway annexing Spitsbergen on behalf of Norway. This was a well-chosen opportunity, as the Franco-Prussian War was raging and offered the chance to annex Spitsbergen under the diplomatic radar, so to speak. However, after initially receiving a positive response on the condition that fishing rights and shipping would not be affected, considerable debate in the Russian press led its government to reject the idea. After some discussions, this resulted in the Swedish government abandoning the attempted annexation in 1871.

This did not prevent Dickson and Nordenskiöld, along with business colleagues, from reworking their proposal in May 1872, after forming the Isfjorden limited company for phosphate mining and scientific exploration on Spitsbergen. This time, after a new round of notices to the relevant countries, the answer was that Spitsbergen's position as *terra nullius* was unchanged, but that the company could count on no other stakeholders being permitted to stop its plans.

But there was to be no phosphate mining on Spitsbergen this time either. However, the triumvirate of Nordenskiöld, Dickson – who was elected into the Academy in 1878 – and von Otter still demonstrate how scientific, economic, military and diplomatic interests had an inextricable influence upon various polar projects.

THE VEGA EXPEDITION, from 1878 to 1880, was no exception. This time, the scientific aim was to find the long desired Northeast Passage north of Russia, between the Atlantic and Pacific, and to explore this part of the Arctic Ocean. Hopes had been raised by a sealer that had found two part-passages in 1869; these were narrow and difficult to navigate, but not as full of ice as the broader passage that had previously been attempted. Nordenskiöld had led Yenisei expeditions in 1875 and 1876, showing that it was possible to force these passages, thus opening the route for an attempt on the entire Northeast Passage.[143] In particular, Nordenskiöld's suspicions had been confirmed; the coast of the Arctic Ocean did thaw in the summer due to freshwater flowing into the ocean from the huge Russian rivers. Because of the Earth's rotation, this warmer water should move eastwards along the coast and, if so, a ship should be able to move with it to the Pacific Ocean.

ESSAY
The Nordenskiöld game
p. 417–421

These scientific ambitions came with economic incentives. The discovery of a new and shorter trade route to Siberia and Asia would, naturally, be financially worthwhile. This expedition was once again financed by Dickson, but King Oscar II also contributed, along with a number of private individuals and the Swedish Society for Anthropology and Geography, as well as the Royal Society of Arts and Sciences in Gothenburg.

The Vega expedition had a crew of 30, including 9 researchers and officers, departing at the height of summer in 1878. Their journey then moved slowly north of Russia, where the ice gradually increased. At the end of September they were finally frozen in, not far from the Bering Strait between Asia and North America, and forced to overwinter, though this had been planned for. The winter was used for scientific studies, primarily anthropological ones of the Chukchi people.[144]

But it was a long wait. It took until the middle of July 1879 for *Vega* to be able to continue her journey, with streamers, steam and full sail. The expedition thus became, after a long winter in the ice, the first to navigate the Northeast Passage. The voyage then moved into more familiar waters and nine months later, in April 1880, they berthed at Stockholm Palace to fireworks and festivities.

So, a few years after the Riksdag had decided upon a central meteorological office under the auspices of the Academy of Sciences, Adolf Erik Nordenskiöld returned from his soon-to-be famous Vega expedition. Like previous leaders of polar expeditions, Nordenskiöld was presented in various media contexts as a scientific researcher in the form of an adventurer, a hybrid that scientists themselves also articulated and promoted to make it easier to motivate and finance these relatively expensive expeditions. Polar environments were presented as beautiful and mystical, wild and harsh. Unaffected by human culture, they were worth exploring and surveying, although this was something with which only the mythological and heroic scientific researcher could be trusted.[145]

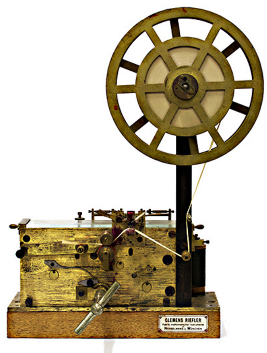
UNDER NORDENSKIÖLD'S LEADERSHIP, and soon that of Alfred Gabriel Nathorst, curator of the paleobotanical department at the Museum of Natural History, in the following generation, polar expeditions resulted in masses of material that entered the museum's collections. In this way, the collections had a preservatory function that characterised a great deal of scientific activity from the 1870s to the 1910s.[146] At the same time, the museum became an institution that maintained similar ideas about the pristine nature of Sweden as that of the polar regions. This made it something of a predecessor to the Swedish nature conservation movement, of which Nordenskiöld has often been regarded as the progenitor, since he likened Sweden's nature to a museum.[147]

In 1880, Nordenskiöld used his new-found fame from the Vega expedition to propose the founding of national parks that would protect areas of nature otherwise threatened by exploitation. There was thus a clear link between the Academy of Sciences' somewhat scientific expeditions and the nature conservation movement.[148] The proposal for a national park may also have been inspired by the American protected areas of Yellowstone, which became a national park in 1872, and Yosemite, which was protected in 1864 and awarded national park status in 1890. In any event, Nordenskiöld lobbied for the creation of Swedish national parks that were to remain untouched, with the aim of preserving nature that otherwise risked destruction.[149] It was from these ideas that, in the early 20th century, the Academy of Sciences was to carve out national parks, protected statuses and nature conservation legislation,[150] but this is a process that is described in more detail in the next chapter.

Standards

A considerably more practically focused activity that resulted from the almanac monopoly and the Academy's always lively and almost path-dependent interest in astronomical observations, which became material in the observatory and other places, was responsibility for national timekeeping. In Sweden, timekeeping was local until the 1870s. For example, the time difference between the two major cities on the west and east coast respectively, Gothenburg and Stockholm, was 24 minutes. This, however, was complicated in 1862, when people began to travel between the cities by train. So that the timetables would not be too difficult to read, the railway decided to use the local time in Gothenburg; at least then there was no risk of missing the train, if you used the timetable without converting it to local time. The national system was made more complicated by the timekeeping at the Telegraph Administration using the Copenhagen meridian, so it could connect to the international telegraph network. In 1864, with the aim of somewhat reducing the confusion, station clocks with double minute-hands were introduced: one that showed the local time and one that showed the railway time. Even if the intentions behind the new clocks were good, it is unclear whether they had a calming effect on the passengers. It is no surprise that discussions soon started about the introduction of a uniform national time.

The same year, 1864, the Academy of Sciences was tasked with investigating how this could be done. Despite this inquiry taking just one week, the political decision took fourteen years to make. Still, in 1878, the Riksdag decided that Sweden – as the first country in the world – would introduce a legislated national time from 1879, namely the local time three degrees west of Stockholm Observatory. This was reasonable, given that the meridian went through the parts of southern Sweden with the densest population. Meanwhile, Stockholm Observatory started to broadcast signals via the telegraph network to help various groups set the correct time. At the start of the 20th century, national time was replaced by the internationally determined Central European Time (CET), one hour ahead of Greenwich Mean Time. However, this had no consequences for the average Swede, as CET and the Swedish national time differed by only fourteen seconds.[151]



ESSAY
Trustworthy time
p. 556–560

IN PARALLEL WITH THE VARIOUS EFFORTS at forecasting the weather, polar voyages and national standard time, the Academy of Sciences also participated in international work to introduce the metric system of measures. The background was increased trade in Europe, resulting from industrialism and greater capacity in transport systems. In this context, the regional and national differences in units of measurement were a growing barrier to the exchange of goods between regions and countries. A unified system of measurement had been developed at the end of the 18th century, after the French Revolution, and introduced in France in the early 19th century. After Prussia legally adopted the system in 1868, and an international geodesy congress in Berlin recommended international cooperation, an international commission met for the purpose of introducing the metric system of measurement with a standard metre for length and a standard kilogramme for weight. One result was the creation of a transnational international office for weights and measures in Paris in 1875.[152] Sweden was one of the 17 founding countries, with the Academy of Sciences as its representative. Academy members included early proponents of the French metric system, such as Berzelius, who had expressed his support for the French standard measure in a chemistry textbook back in 1818.[153] The Academy of Sciences also produced the information that was the basis of the 1876 Riksdag decision to introduce the metric system in Sweden, which came into force in 1889.

The reason for the delay was the enormous amount of development work necessary for the designing the prototype metre and kilogramme, and finding suitable alloys, followed by extremely precise comparisons between international originals and national copies that were to be distributed to the countries participating in this cooperation. In 1889, Sweden was finally able to have its national prototypes for the metre and kilogramme, which were then stored in the physical cabinet at the Academy of Sciences, in a fireproof safe in a fireproof vault. All in accordance with an exactly worded royal decree.[154] They were kept there until 1935, when they were moved to the Royal Mint on the island of Kungsholmen in Stockholm.[155]

That precision was important, even decisive, was demonstrated by a control measurement performed by the astronomer and secretary of the Academy of Sciences, Georg Lindhagen, on a French "perfect" metre that was taken to Uppsala from Paris in 1867, to function as a provisorium.[156] It became apparent that the prototype metre in Uppsala was considerably shorter than had been believed – there was a different of six to eight hundredths of a millimetre, instead of two hundredths. The consequences were disastrous, as huge numbers of detailed measurements of solar wavelengths thus proved to be pretty much worthless.[157]

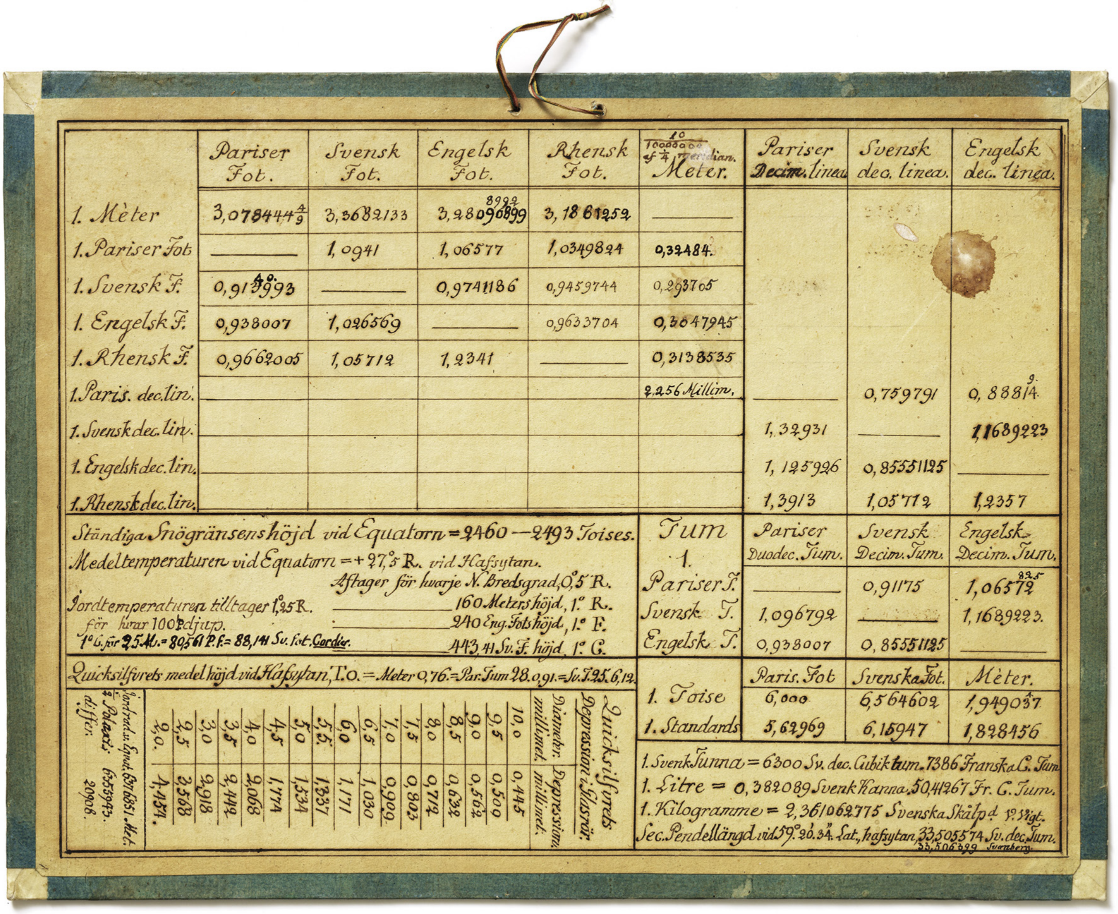


TABLE OF UNIT CONVERSIONS used by Wilhelm Hisinger in his work in Skinnskatteberg. There were many rival units of length prior to the standardised measurement system.

MEASURES BOX with various established units of volume. This was a tool for Otto Ekerot who, from 1883 onwards, was adjuster of measures in the 14th adjustment district, county of Kalmar, around the time the metric system was introduced.

THE INVOLVEMENT OF THE ACADEMY OF SCIENCES in the measurement system and in time measurement, as well as in meteorological observations and scientific expeditions in the 19th century, has been presented as a great change compared to the often practical advice and findings that were its primary occupations in the previous century. More specifically, it could be claimed that the Academy went from concrete contributions with relatively small results, primarily in agriculture, to abstract, more general efforts with a clear effect on large areas of society.[158] This shift has been explained by industrial society's demands on precision with the ensuing increased need for standardisation. In addition, various sectors had more general requirements for planning their activities depending on the weather. In the same spirit, scientific expeditions can partly be seen as attempts to expand the utilisation of natural resources and raw materials outside the actual borders of Sweden.

Meanwhile, there is no doubt that the years around 1900 were the golden age of the Academy of Sciences. Its traditional activities were concretised in the Bergius Botanic Garden which, in 1885, had moved to Frescati on the shore of Brunnsviken, north of Stockholm, as well as in the new Swedish Museum of Natural History that followed it thirty years later. Both had become institutions of national and international interest. The same applied to the Central Meteorological Office and Kristineberg Zoological Station. At the turn of the century, only the observatory appeared to have become outmoded. It was not by chance that this was when the Academy of Sciences received the prestigious task of awarding the newly founded Nobel Prizes in Physics and Chemistry, with the associated status, honour and money.

Alfred Nobel's legacy

After the turn of the century, the Academy of Sciences increasingly began to establish research institutes. From the early 20th century, the Thamic lectures were once again delivered by Academy physicists. The primary reason for the rejuvenation of the experimental and theoretical sciences was that the Swedish industrialist and financier Alfred Nobel, an Academy member from 1884, had died in 1896, leaving a will that prescribed the awarding of a prize. The Academy of Sciences was named as the recipient of this bequest.[159] Nobel – whose enormous fortune primarily came from the development and

USING A FULL PAGE OF *DAGENS NYHETER* in 1926, Åke Berglund describes the rapid developments in medicine at the start of the century, in relation to breakthroughs in the natural sciences that were awarded Nobel prizes.

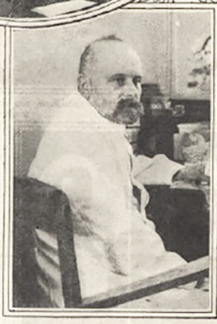
DIT LÄKARVETENSKAPEN HUNNIT

De medicinska Nobelpristagarna och deras verk. En studie över medicinens utveckling under det första kvartsseklet av vårt århundrade. För Dagens Nyheter av med. lic. Åke Berglund.

Professor A. Gullstrand i Uppsala. 1911 belönad för forskningar rörande ljusstrålarnas brytningsförhållanden i ögat. (För Dagens Nyheter nylaget porträtt.)

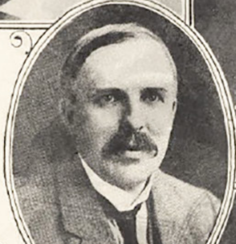
Professor Svante Arrhenius, en av de första Nobelpristagarna. (För Dagens Nyheter nylaget porträtt.)

Professor Archibald Hill, som studerat muskelmaskinens mekanik, hyllas av sina lärjungar.



Professor Robert Bárány, Uppsala. (För Dagens Nyheter nylaget porträtt.)

Engelsmannen Soddy, vilken nedlagt betydande förtjänster för utforskandet av strålningsföreteelserna.



Professor Ernest Rutherford, vilken tillsammans med Soddy studerat strålningsföreteelserna.

Professor Charles Richet.

Madame Marie Curie, som upptäckte radium.

Professor Macleod, en av insulinets upptäckare.

Professor Banting, en av insulinets upptäckare.

Om man med ledning av de medicinska Nobelpristagarnas verk vill försöka framställa en bild av den medicinska vetenskapens utveckling under det första kvartsseklet av vårt århundrade, får man en stark känsla av i vilket nära sammanhang medicinens utveckling står till framstegen inom de rent naturvetenskapliga leden. Jag behöver bara nämna namnet på den förste i raden av samtliga Nobelpristagare, Röntgen, vilken 1901 erhöll priset i fysik eller madame Curie, som erhållit Nobelpris både i fysik och kemi för sina arbeten om radium och radioaktiviteten, för att ge en klar bild av huru nya, friska och fruktbärande grenar på det medicinska lärosätet framvuxit direkt ur fysiska och kemiska forskningar. Som vi skola se, äro dessa båda forskare icke de enda pristagarna i fysik och kemi, vilkas verk spelat en avgörande roll inom medicinen.

Ja, granskar man den långa raden av pristagare i medicin och fysiologi, skall man finna att de upptäckter som prisbelönats samtliga äro arbeten av rent naturvetenskaplig karaktär, i det att de alla sysslа med antingen fysiska eller kemiska problem eller i de flesta fall med biologiska, d. v. s. studier över formerna och fenomenen inom den levande organismen, vare sig det nu gäller den högt komplicerade människokroppen eller den primitiva, enkla bakterien, eller amöban.

Den medicinska vetenskapens framsteg under det senaste kvartsseklet synes alltså helt och hållet gå i naturvetenskapens tecken.

Röntgens upptäckt skapade en ny medicinsk vetenskap.

En naturlig indelningsgrund för en historik över framstegen inom medicinen och över de för medicinen betydelsefulla Nobelpristagarnas verk torde därför ett uppdelande av dessa arbeten på de tre områdena fysik, kemi och biologi utgöra.

I den första gruppen ha vi redan nämnt de stora namnen Röntgen och Curie. Kring dem gruppera sig naturligt en rad pristagare, vilkas insats närmast skall med några ord omnämnas. Som en föregångare och banbrytare för Röntgens upptäckt bör i första rummet nämnas ungraren Philipp von Lenard, professor i Kiel, vars viktiga arbeten om katodstrålningen 1905 belönades med Nobelpriset i fysik. Dessa arbeten öppnade nya fält för den fysiska forskningen om olika slag av strålning och gåvo impulser till sökandet efter andra källor för liknande strålning vilka ledde till de för medicinen så utomordentligt betydelsefulla upptäckterna av röntgenstrålarna och radioaktiviteten. Röntgens upptäckt av hans strålars förmåga att passera en mängd för ljuset ogenomskinliga kroppar har lett till deras användning inom den medicinska diagnostiken, och utan överord torde kunna sägas att de nu på 30 år skapat en hel ny medicinsk vetenskap och, som bekant, fått en så vidsträckt användning inom det praktiska läkararbetet som väl ingen undersökningsmetod före densamma.

Hur mycket exaktare kan icke, tack vare röntgenstrålarna, läkaren av i dag avge ett utlåtande om tillståndet i t. ex. en tuberkulös lunga eller bestämma läget för en skada på skelettet, för att blott nämna två mycket vanliga användningar av röntgenljuset. Kommer så därtill att röntgenstrålarna fått en utomordentligt vidsträckt användning för behandlingsändamål vid de mest skilda åkommor, såsom inflammationer i huden (eksem, finnar etc.), ledgångar och körtlar (framför allt körteltuberkulos), vid en mängd blodsjukdomar, vid olika svårartade tumörer och inom området för de viktiga rubbningarna i de s. k. inresöndringsorganen. För behandlingen av tumörsjukdomar, framför allt den ocrhört utbredda kräftsjukdomen, har emellertid upptäckten av den s. k. radioaktiviteten genom parisaren Becquerel och makarna Curie, belönat med 1903 års pris i fysik, och av ämnet radium av madame Curie, Nobelpristagare i kemi 1911, haft en ännu större, alltjämt växande betydelse. Dessa forskare upptäckte radiums med flera kroppars förmåga att av sig själva kunna utsända med röntgenljuset besläktade strålar, och dessa upptäckter ansluta sig värdigt till Röntgens insats i fysikens och framför allt inom medicinens utveckling.

Utomordentligt betydelsefull för den medicinska behandlingen blev även den av dansken Niels Finsen införda metoden att behandla sjukdomar, särskilt hudtuberkulos (lupus), med koncentrerade ljusstrålar. Det av honom grundlagda Finseninstitutet i Köpenhamn och efter dess mönster över hela världen inrättade anstalter för ljusbehandling vittna om den utbredning och betydelse hans upptäckt fått.

För det fortsatta utforskandet av dessa strålningsföreteelser och därmed sammanhängande spörsmål representativa namn äro de båda kemipristagarna engelsmännen Rutherford och Soddy och pristagarna i fysik tysken von Laue och engelsmannen Barkla.

På huvudsakligen fysiska grunder bygga också svensken Gullstrands år 1911 prisbelönade märkliga arbeten om ljusstrålarnas brytningsförhållanden i ögat och avbildningen av föremål i ögat, vilkas betydelse för studiet av ögonsjukdomarna varit av mycket stor betydelse. Särskilt frågan om ljusbrytningen i ögonlinsen och sättet varpå linsens form ändras vid seende på olika avstånd ha genom Gullstrand fått sin definitiva lösning.

Framställaren av veronal, en förgrundsfigur bland Nobelpristagarna.

Övergå vi till en redogörelse för de för medicinens utveckling viktigaste upptäckterna inom kemin som belönats med Nobelpris, torde vi i första hand böra nämna de banbrytande arbetena av holländaren, Berlinprofessorn van't Hoff och av svensken Svante Arrhenius, den förre första pristagare i kemi år 1901, den senare prisbelönad år 1903. Att deras för den moderna kemin och även fysiken grundläggande utredningar om de fysikaliskt-kemiska förhållandena i lösningar skulle vara av den största betydelse även för den moderna biologin och medicinen framhölls redan vid utdelandet av det första kemipriset. F. d. riksarkivarien C. T. Odhner avslutade sitt tal för van't Hoff med dessa ord: "Utredningen av tillståndet i lösningar har medfört och skall medföra de största vinster för, vilka gagn för mänskligheten blott insess, om man besinnar att det är i lösningar som de kemiska reaktionerna företrädesvis försiggå och att de levande organismernas livsfunktioner upprätthållas genom ämnesomsättningar som ske i lösning". I dessa dagar, då utredningen av flodets kemiska sammansättning och dess förändringar vid olika sjukliga tillstånd är en av de intressantaste och livligast bearbetade medicinska frågorna på dagordningen, ligger mer än vanligt den medicinska vetenskapens beroende av kemin och de här berörda glänsande upptäckterna i öppen dag.

Stor betydelse för fysiologin, d. v. s. läran om de normala livsförrättningarna, och medicinen i dess helhet äga de för den moderna organiska kemin grundläggande arbetena av Nobelpristagarna i kemi, Berlinprofessorn E. Fischer (1902), Münchenprofessorn A. von Baeyer (1905) och professorn i Göttingen O. Wallach (1910) samt pristagaren i medicin och fysiologi, professorn i Heidelberg O. Kossel (1910), alla tyskar.

De för kroppen nödvändiga näringsämnena och de organiska ämnen vilka uppbygga djurkroppen äro av tre olika slag, nämligen äggviteämnen vilka utgöra kroppens nödvändiga byggnadsmassa, fettämnen och kolhydrater (socker och därmed besläktade ämnen), vilkas uppgift i första hand är att lämna det erforderliga energitillskottet för kroppens livsfunktioner, bränslet i den levande maskinen. En av den organiska kemins högsta uppgifter är att utreda och med konst eftergöra de kemiska processer som äga rum i djurvärlden och växtriket, för att därmed bereda en fast grundval för uppfattningen av livsföreteelserna.

E. Fischer tillkommer äran att ha utforskat kolhydraternas kemiska byggnad och klargjort den kemiska process som ligger till grund för bildningen av kolhydrat i växternas gröna delar, en av de mest storartade processer som äga rum i naturen. Denna process utgör i själva verket huvudkällan till all organisk substans, d. v. s. de ämnen som uppbygga de levande varelserna. Dessutom har Fischer utforskat en grupp av i organismen förekommande kväveholdiga ämnen, de s. k. purinämnena (med urinämne besläktade föreningar), vilka antingen äro förbrukningsprodukter av äggviteämnen eller ingå som delar i de sammansatta äggviteföreningar av vilka den levande organismen till största delen är uppbyggd. Det är ju för var och en tydligt vilken vikt kännedomen om dessa ämnen äger för studiet och läkarhjälpen vid de viktiga s. k. ämnesomsättningssjukdomarna, såsom sockersjuka eller gikt. Flera representanter för av Fischer framställda purinämnen, till vilken grupp böra de sedan gammalt som läkemedel använda medlen koffein och theobromin, ha även visat sig synnerligen värdefulla såsom läkemedel, och den kemiska industrin har här fått ett vidsträckt arbetsfält öppnat för sig och framställt en mängd särskilt i hjärt-, kärl- och njursjukdomsbehandlingen utomordentligt värdefulla preparat. Fischer själv framställde det till dessa ämnen hörande utomordentligt sömnmedlet veronal, på vilket ämne ensamt han skall ha förtjänat betydligt mer än ett helt Nobelpris.

Pasteurs teorier korrigeras.

Av stor betydelse ha även Kossels prisbelönade undersökningar över frågan om äggvitekropparnas förening i kroppens minsta levande delar, cellerna, varit. Han har ägnat sina forskningar åt utredningen av dessa äggvitekroppars sammansättning och särskilt åt en grupp av klyvningsprodukter av desamma, som äro "basiska" i motsats till de "sura" klyvningsprodukter av äggvita till vilka purinämnena höra.

Av utomordentligt stor betydelse för den kemiska industrin och därvid även för framställningen av kemiska läkemedel äro även v. Baeyers undersökningar över vissa organiska färgämnen och Wallachs över de s. k. alicykliska föreningarna; bland dessa senare utgöra terpenerna (terpentinpreparat) och kamferarterna den centrala delen, och bland dem finnas, som bekant, viktiga medel använda i den medicinska behandlingens tjänst; likaså bland de av v. Baeyer undersökta färgämnena.

Stor förtjänst om utredningen av de kemiska processer vilka avspegla sig inom de levande organismerna ha även inlagts av Berlinprofessorn Edvard Buchner och f. d. professorn vid Leipzigs universitet, Wilhelm Ostwald. Den förre erhöll 1907 års Nobelpris i kemi för sina arbeten angående jäsningen. Det är Pasteurs oförgätliga förtjänst att ha bevisat att det är levande organismer som äro upphovet till förruttnelse och jäsning m. fl. processer. Han trodde emellertid att jäsningen vore en livsyttring av jästcellerna och därför oskiljaktigt förknippad med deras liv. Buchner fann emellertid att jäsningen beror på ett av jästcellerna producerat ämne kallat ferment. Han öppnade därigenom för forskningen ett viktigt arbetsfält. Det förhåller sig nämligen så att det i synnerligen hög grad är just fermentativa processer som betinga de levande varelsernas ämnesomsättning och som sålunda behärska deras livsvillkor.

Ostwald fick priset i kemi år 1909 för sina arbeten om katalys, d. v. s. den företeelse att ett ämne utan att självt förändras kan framkalla eller, enligt Ostwald, ändra den hastighet varmed en kemisk omsättning förlöper. Den stora betydelse hans upptäckter haft för läran om ämnesomsättningen torde framgå därav att man kommit under fund med att de för de kemiska processerna inom de levande organismerna ytterst betydelsefulla s. k. ensymerna verka såsom katalysatorer. Så ske de kemiska processerna vid matsmältningen med tillhjälp av ensymer i digestionssafterna, och likaså ombesörja dylika upptagandet av den lämpliga näringen i kroppens olika organ.

Tuberkelbacillen upptäckes.

Vi gå nu över till de märkliga biologiska forskningar inom bakteriologins område vilkas främsta namn äro de båda tyskarna Robert von Koch och Emil von Behring, den sistnämnde den första Nobelpristagaren i medicin och fysiologi år 1901, den förre pristagare i samma ämnen år 1905.

Koch fick sitt pris för sina arbeten

(Forts. å sid. elva.)

exploitation of dynamite and other explosives – left an estate with an estimated value of 31.4 million kronor. Of this, around 29 million kronor were put in a fund at the Nobel Foundation, the returns on which were the prize money. The remaining assets were placed in a building fund for acquiring premises from which to administer the Foundation, and five organisational funds for each of the five prize areas: physics, chemistry, medicine, literature and the Nobel Peace Prize.

The uniqueness of Nobel's will did not lie in its initiative to found scientific and literary prizes, even if the peace prize was something of an innovation; there were plenty of different prizes for various types of scientific and artistic achievements at the end of the 19th century. Instead, the prize's distinctiveness lay in its international scope and the amount of prize money. Similar phenomena that indicated the general desire for contests in the 19th century, and interest in national prestige in international competition, while avoiding militarism and armed aggression, were the great exhibitions or world's fairs, beginning in London in 1851, and the new Olympic Games, which started in Athens in 1896. At both of these events, prizes and medals were awarded for a range of achievements. It was no coincidence that the two subsequent Olympics were held at the same time as the expositions in Paris in 1900 and Saint Louis in 1904.[160] Incidentally, in the years around 1900, Sweden was considerably more successful at the expositions, or world's fairs, than at the Olympics.[161]

Thus, through the Nobel prizes in physics, chemistry and physiology or medicine, scientific research gained importance for national competition within the framework of peaceful international coexistence. The Nobel prizes also being awarded in such distinctive fields as literature and peace meant that the scientific prizes could loan prestige from other, more cultural and idealistic, fields. This was no longer just about science as objective knowledge and material progress, but also about cultural activity. The prize's prestige was further boosted by the celebratory format of the award ceremony. However, King Oscar II did not attend the first award ceremony in 1901, the rumour being that he disliked so much money being given to foreigners. Crown Prince Gustaf did this in his stead. The following year, however, the prize was awarded by the king's hand, followed by dinner at Grand Hotel.[162] Due to the Nobel prizes, the Academy of Sciences rapidly gained something of an internationally exceptional position in evaluating achievements in physics and chemistry, a position that was further strengthened by Sweden's officially neutral position in international politics.[163]

Outside the world's fairs, throughout the 19th century there had been numerous national prizes in science and technology. In fact, several Swedish prizes had been awarded by the Academy of Sciences, but because the Nobel prizes were international and received a great deal of publicity, both in the

Swedish and international press almost immediately after Nobel's bequest had become known, this was a new kind of commitment for the Academy.

THE ACADEMY'S TASK WAS to decide the laureates in physics and chemistry, while the laureates in physiology or medicine were decided – and still are – by a Nobel committee at the Caroline Institute. Significant compensation was expected as a reward for this work, bearing in mind the size of the monetary prizes.[164] In negotiations with the executors of the will, the Academy of Sciences was represented by a five-person committee, which included the Thamic lecturer Bernhard Hasselberg and the permanent secretary. In a response to the executors in March 1897, they proposed that, in the absence of deserving achievements, prize money that was not awarded could be used by the Academy to create a Nobel institution. One had been mentioned in Nobel's will as a form of research institute at which praiseworthy work could be evaluated.[165]

At the same time, many Academy members who were cautiously sceptical about the task of awarding the Nobel prizes. This was partly because international prizes of this scale could send the Academy's activities in an inappropriate direction, and partly fear that the prize could cause corruption among the members.[166] In June 1897, things came to a complete stop at the Academy when, at a meeting that was open to all Academy members, the decision was made to put discussions about awarding the Nobel prizes on hold until an agreement had been drawn up with the Nobel family. Once the process of interpreting the will and establishing the Nobel Foundation was completed through an agreement with the family in 1898, the Academy could resume its discussions, which entered an intense phase in the early spring of 1899.

Ideas about Nobel institutions were also developed, becoming increasingly definite. In 1898, there had been talk about creating one large Nobel institute for the three science prizes, in physics, chemistry and physiology or medicine. It would house laboratories, a library and other research infrastructure, where employed researchers could evaluate discoveries and inventions. There were different versions of the proposal, but what they had in common was that this Nobel institute would have close ties to Stockholm University College, with professors being able to perform some of their work at the institute. According to the most optimistic plans, this would be built on Observatoriekullen, not far from the premises of the Academy of Sciences, with Stockholm University College a little further down Drottninggatan.[167] The proposal was undoubtedly supported by several Academy members who had also been active in founding Stockholm University College a few decades earlier, not least because such an investment would improve opportunities for its teaching staff to conduct research. A Nobel institute could also make a valuable contribution to resources at a time when the university college was under financial pressure.

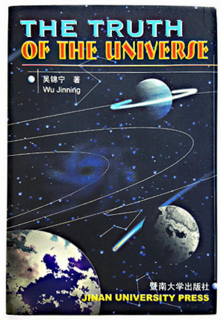
However, the idea of an institute was abandoned later in 1899. Instead of a specific Nobel institute, a thorough set of rules was developed to guarantee that the prizes were used to reward achievements worthy of praise; they were adopted in the spring of 1899 and approved by the King in Council just over a year later.[168] This Nobel system meant that two different Nobel committees were established, one for physics and one for chemistry, as preparatory bodies for the relevant Nobel prize. The committees started by gathering prize nominations from a great many researchers around the globe. Among those who were able to nominate potential laureates were Swedish and foreign members of the Academy of Sciences and its Nobel committees, previous Nobel laureates and professors of physics and chemistry at Swedish and other Nordic universities and university colleges. In addition to these permanent categories were professors of physics and chemistry at a minimum of six foreign universities and a number of leading researchers around the world, who were invited to submit nominations on the strength of their individual merits.

The Nobel committees for physics and chemistry compiled the nominations and weeded out the names. The committee members often investigated the work and suitability of the nominees. It was not until many years later that experts outside the Nobel committees were brought in for these tasks. When the committees had each arrived at a proposed laureate, they were discussed in the classes for physics and chemistry at the Academy of Sciences. These submitted statements before it was finally time for a decision, which was taken by the entire Academy of Sciences. It was not uncommon for meetings at which Nobel prizes were discussed to attract considerably more members than other meetings.[169]

The Nobel prizes

The Academy of Sciences was thus the body that decided on the recipients of the Nobel prizes in physics and chemistry, after proposals from the relevant Nobel committee. It soon became apparent that this entailed a great deal of debate of a fairly basic character, about what type of science should be regarded as praiseworthy in comparison to others. Historians have put plenty of effort into examining discussions about potential laureates and the attempts to mobilise colleagues to support one scientist rather than another.

One area of discord that would soon be noticeable in the assessment of scientific contributions was which evaluative principles should apply and, by extension, what type of research should be rewarded. For example, how should theoretical contributions be compared to empirical ones? This was relevant because some Swedish physicists and chemists were empirically focused and thus found it difficult to assess new theoretical work, or doubted its value if they understood enough to evaluate it. Here, atom theory was a point of contention in the early 20th century, as were, later, the status of the theory of relativity and whether quantum physics was worthy of a Nobel Prize.[170]



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These weaknesses were also due to difficulties in interpreting what should actually be rewarded with a Nobel Prize in physics or chemistry. There were many long discussions about what Nobel's ambiguous and notoriously difficult to decipher will called "the most important discovery or invention" in "the field of physics" and "the most important chemical discovery or improvement". In addition, there was the overarching condition that the Nobel prizes should be awarded to those who "during the preceding year, shall have conferred the greatest benefit to mankind".[171]

Another important issue in this evaluation was what could be considered as falling within the fields of physics or chemistry. Whether astrophysics or meteorology was within the bounds of the physics prize seems at least partly to have been linked to who was included in the Nobel Committee for Physics. Similarly, the issue of whether mineralogy or biochemistry were part of chemistry was partially dependent on the composition of the chemistry committee.[172] At any rate, the field of physics soon came to include almost anything from theoretical work to the construction of, and measurements with, precision instruments. However, in terms of subjects, its focus was relatively narrow as meteorology and astrophysics, for example, were barely rewarded.[173] Not, at least, until long after the end of the World War Two.

Another issue of evaluation that was often on the table was, of course, what should be regarded as discoveries, inventions or improvements.[174] As the Nobel committees were peopled by scientists, it was rare for pure inventions or more pronounced improvements to be rewarded. However, there were exceptions, such as the radio technology that was honoured in 1909, with a prize for Guglielmo Marconi and Ferdinand Braun "in recognition of their contributions to the development of wireless telegraphy".[175]

Nor was it easy to decide what was the *most important* discovery, invention or improvement. The wording was so difficult to deal with that, fairly soon, it was used more to question than to benefit different proposals. It was even more difficult to limit prize contributions to those which had conferred the greatest benefit on mankind *during the previous year*. In the 1899 statutes of the Nobel Foundation, this provision was interpreted as the most recent achievements being those that should be rewarded, with older discoveries or inventions only being considered if their significance has recently become apparent. The wording has been freely interpreted and the first prize in physics went to Wilhelm Röntgen for his discovery of X-rays, which he had made

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back in 1895. The first chemistry prize, to Jacobus Henricus van't Hoff, was for discoveries made many years previously, in the mid-1880s. Since then, Nobel prizes have consistently rewarded work older than a year.

Another area of tension was the distribution of the Nobel Prize between different countries. For example, it turned out that researchers had a preference for nominating colleagues from their own country, particularly during periods when national chauvinism has influenced the nominations, such as at times of war. This was despite scientific research being a field that was often assumed to be about internationalism rather than nationalism, at least rhetorically.[176]

On the other hand, at times of national tension, the Nobel Prize could be a potential resource for re-establishing trust between researchers from different countries, an idea that also had an impact on discussions about which physical and chemical discoveries should be rewarded. In such contexts, it was often mentioned that the practice of science should be neutral and stand above politically motivated boycotts. However, even if most people agreed with the ideal of neutral and international science, there was still significant room for negotiation in discussions about suitable candidates for the Nobel Prize. World War One, in particular, and the boycott of German scientific exchange that the winning nations maintained against the Central Powers until 1926, coloured discussions about suitable Nobel laureates and the pros and cons of rewarding German, British, French or other researchers. This was additionally complicated by physics and chemistry making concrete contributions to the horrors of the battlefield, with poison gas and increasingly effective explosives.[177] Developments were everything other than marginal at the end of World War Two and in the subsequent balance of terror in the Cold War, with atomic bombs and nuclear weapons.

A third area of tension that has been discussed in detail regarding Nobel Prize decisions comprises the local networks and institutional conditions within the Nobel committees, the Academy of Sciences and neighbouring organisations, such as Stockholm University College, and how they influenced decisions about Nobel laureates. In this context, many people have highlighted the antipathies, or pure enmity, between Svante Arrhenius in the Nobel Committee for Physics and mathematician Gösta Mittag-Leffler. Both launched campaigns for their favourites and did all they could to prevent the other's preferences from having an impact on the Academy of Sciences.[178] In this context, the variance in views regarding the different research traditions between physicists at the more progressive Stockholm University College and the more traditional and empirically focused university in Uppsala must also be mentioned as an important factor when analysing the Academy's choices of Nobel laureates.[179] Other circumstances that have been mentioned are the rule that prize money for a Nobel Prize that has not been awarded in a particular year or the following year, goes to the deciding body. Because the Nobel Prize was not awarded in numerous years in the 1910s, 20s, 30s and 40s, it has been claimed that the money was instead used to boost research in physics and chemistry through the founding of the Nobel institutes.[180]

EVEN IF IT MAY SEEM OBVIOUS that local Swedish conditions probably affected the choice of Nobel laureates, for the simple reason that only Swedes manage the selection and decision-making processes – at least until the 1950s, when external experts were first employed – this idea has been criticised.[181] But in the same way as it is difficult to detach the idea of the Nobel Prize from ideas about peaceful international competition in sports and technology in the years around 1900, it is also difficult to separate the practices of awarding the prize from local institutional conditions at the Academy of Sciences, in Stockholm and in Sweden – at least until about 1970, when it became more common to let foreign experts investigate the work of nominated researchers.

The Nobel Institute for Physical Chemistry at the Academy of Sciences

When the final statutes for the Nobel Foundation were established in 1900, the institutions awarding the prizes appeared to be the foremost beneficiaries. For example, the Academy of Sciences had received a sizeable grant for establishing a Nobel institute and the right to funding for work on the selection process. It also received assets that were placed in a restricted fund, in which reserved prize money was placed.[182] The first year the prize was awarded, 1901, the prize money amounted to 150,000 kronor, thus making each individual prize larger than any other in the world. The size of the prize amounts can perhaps best be described by stating that the biggest prize awarded by the Academy of Sciences thus far, the Letterstedt Prize for important discoveries and to excellent authors, from the 1860s, amounted to 4,000 kronor.[183]

However, plans to build a Nobel institute for physics and chemistry were not entirely shelved; instead they became realistic in association with discussions about a newbuild for the Academy. A building committee was appointed in May 1901 and, eventually, land was purchased from the state, the idea being that it could also house a Nobel institute for physics and chemistry.[184] These formative events in the history of the Academy of Sciences were just as much a result of the overflow of objects at the Swedish Museum of Natural History and the books in the library on Drottninggatan, as of the new opportunities provided by funding from the Nobel Foundation.

THINGS DID NOT REALLY GO AS INTENDED and, instead, the Nobel Institute for Physical Chemistry was partly founded for reasons other than the evaluation of discoveries and inventions. At a meeting of the Academy of Sciences in the late autumn of 1904, Svante Arrhenius, professor of physics at Stockholm University College, announced that he had been offered a "particularly advantageous" position in Berlin with the opportunity for scientific research. Arrhenius had been a member of the Nobel Committee for Physics since it was founded in 1900 and had also, as the first Swede, received a Nobel Prize (in chemistry) in 1903, which can be seen as an indication of his leading position in Swedish and international science.[185] At the same time as Arrhenius announced the offer from Berlin, he also said that he would prefer to stay in Sweden if he had an equivalent offer. A few weeks later, the Academy of Sciences requested the establishment of a department for physical chemistry using the Nobel institute's budget, while Arrhenius was offered the directorship and a professor's salary, which was approved by the King in Council.[186]

It was decided that activities would begin on a small scale until the planned newbuild had been completed. On Arrhenius' suggestion, the Academy decided to rent a three-room apartment, and a home for Arrhenius, on Kungsholmen in Stockholm. The institute's budget was also set at the somewhat astounding annual total of 20,000 kronor.[187] (At that time, Lund University's physics department had a budget of 4,000 kronor.)[188] In addition to Arrhenius, the institute was staffed by an assistant and a caretaker, and it had its own series of publications. This Nobel Institute remained on Kungsholmen until July 1909, when the new building was completely finished; this was in Frescati, outside Stockholm and very close to the new building for the Academy. The costs of the building, which had been divided between the organisational funds for the physics and chemistry departments, were adequate for a three-storey stone building with an area of around 780 square metres.[189] The newbuild had increased the number of research spaces to around ten, and a handful of visiting researchers came every year, both from Sweden and abroad.[190]

So, the Nobel Institute had been intended to function as a tool for the Academy, to confirm ambiguous research results or to remove uncertainty in the selection process for the Nobel prizes. However, there are no indications that such activities took place at the institute. Instead, Arrhenius appears to have used its resources for his own benefit. The institute had been almost entirely shaped on his initiative and his terms, which was possible due to his membership of the building committee. The research laboratory appears to have functioned more as a private one, rather than as the Nobel Foundation's or that of the Academy of Sciences.

Conclusions

In the 19th century, the Academy of Sciences underwent an almost improbable transformation, from a relatively marginalised group of members who represented different sections of society, to an esteemed and high-status academy in which only the best scientists had a place. The reason for this metamorphosis was not simply that the members had academicised so that, at the end of the 19th century, they were mostly university-employed professors in the sciences; efforts to publicise various scientific activities and discoveries among bourgeois public life were probably even more important. This was not just the public activities of the Academy of Sciences, at the Swedish Museum of Natural History and the Bergius Botanic Garden. At least as important were the polar voyages, so widely publicised in the media, and the Central Meteorological Office's weather forecasts that reached every newspaper. The Academy of Sciences was also central to the introduction of standard time and standard measures in Sweden, something that was soon noticeable in everyday life for the majority of people. All of these contributions to new forms of knowledge circulation in the 19th century were crowned and confirmed by the institution of the Nobel Prize in the years around 1900. This was when the Academy could really reap what it had sown.

Naturally, the successes of the Academy of Sciences cannot solely be credited to itself. The Academy rode on a general wave of optimism that was often based on technical insights that were increasingly, at least rhetorically, linked to scientific discoveries. It was not for nothing that there were increasingly intense discussions during the 19th century on the introduction of more science and mathematics in schools. It was not for nothing that it was often described as "the age of steam and electricity". It was not for nothing that science was regarded as something positive, something it was always beneficial to be associated with, whatever the reason. This was equally applicable to those who advocated greater political progressiveness and those who argued for an increased use of resources in industrial capitalism.

Naturally, the success of the Academy of Sciences also rested on the general cultural climate, but the Academy also demonstrated great adaptability to the demands of the time. With the help of the skilled and forceful permanent secretary Berzelius, this knowledge organisation succeeded in redirecting its activities, from an academy that was modelled as a meeting place for gentlemen from different fields, who could discuss and publish new findings and suggest how they could be put to practical use, to an academy that built its activities around more resource-heavy research in the form of expeditions and field stations, astronomical observations and laboratories. In this way, Berzelius' comprehensive reshaping of activities at the end of the 1810s can be understood as a formative process that was largely built on internal initiatives.

However, in the 19th century there was also significant continuity in the sustained collection of specimens, instruments and models – all expressions of an empirically-focused view of knowledge that has long characterised much of Swedish science, from Linnaean botany to experimental physics. From its very beginning, the Academy of Sciences was a stronghold of this type of scientific perspective, inherited from the Royal Society in London, among others, and maintained during the 19th century. As empirical research often has material prerequisites and also generates material relics, this febrile collecting can be understood in terms of path-dependence, in which new generations of researchers chose research problems based on existing collections that they were expected to build upon.

The results of this collecting and categorisation were displayed in the Swedish Museum of Natural History, while the results of the astronomical observations and experiments conducted with the instrument collection were presented at the public lectures in the capital city and, of course, in all the scientific publications. During the 19th century, the Academy of Sciences provided something of a scientific infrastructure in Stockholm, with lectures, premises, collections and a library, and so affiliated itself with that era's view of how knowledge could most effectively be put to practical use: not through a discussion club for the societal elite, but by informing the interested general public, particularly school pupils, and by organising advanced education for youths who, indeed, still came from the societal elite and were almost exclusively male. This also involved slowly redirecting activities so that, from the 1870s, they were more institutionally uniform with those of higher education institutions and the museum that began to be created at this time.

The early decades of the 20th century also entailed a slow process of change, of the same type as the decades following the previous turn of the century. This time, the Academy of Sciences academicised through the members increasingly being occupied in research and higher education. After 1900, the more practically focused branches of knowledge, such as meteorology and polar research, botany and ethnology, slowly began to take a back seat at the Academy, benefitting the experimental and theoretical sciences such as physics and chemistry. This process was reinforced by the Academy of Sciences being entrusted with appointing the Nobel laureates in physics and chemistry, which in itself led to a formative process, this time due to an external initiative. As described in chapter 3, there was another upswing for astronomy in 1930, when a new observatory, with new instruments and telescopes was built in Saltsjöbaden, at a reasonable distance from the disruptive lights of the city.[191]