4 | *The Academy of Sciences as a bridgehead for knowledge policy*

1739–1820

It was another time. Power was exercised with reference to God and the fatherland; the king was a powerful factor in political life and the nobility dominated the nation's highest councils, while also having sole right to higher positions in the collegiums for state administration. Everyone had a given place and the political order was decided by the four estates of the Riksdag. The peasants were in the majority, but had the least say. Agriculture was the mother of all industry, with almost everyone living off the land in one way or another. This was the context in which the Academy of Sciences was founded, to promote the use of knowledge for the public good. This chapter describes the origins of the Academy and its first eighty years of activity: it is primarily chronological, but not entirely. There are sometimes interruptions, such as when the population statistics project is described until its activities were hived off as the Central Statistical Commission.

The Academy is founded

The Riksdag that ended in April 1739 had brought about a political revolution for Sweden. For the first time, the Hats had dominated. This was a trade-focused party that wanted to protect domestic production, including textiles, with protective tariffs and generous loans to manufacturers of various kinds. It represented the idea that the sciences could be used to exploit the nation's natural resources and its poor in a more efficient manner. It stood for a mechanistic conception of the world, where new claims to knowledge were an effective means of confirming the world as God's creation; this was not a God who interfered in the workings of the world, but a cosmic watchmaker – a familiar analogy in the 18th century – who put the world into movement and then let it tick along by itself. The Hat Party did not hesitate in providing significant support for scientific projects that could lead to more efficient production and better knowledge about the nation and its people, or which ideologically supported the prevailing ideas of God. This was a time that celebrated scientific role models such as Polhem, Linnaeus and Celsius, famed as they were throughout Europe.

The Academy of Sciences was founded in 1739, partly as a result of the Hats taking power during the Riksdag that had just ended. This was obviously a formative course of events but, from the start, this new assembly rode on a wave of scientific academies and learned societies, ones that had been created in Europe since the 17th century and which, in some places, became important forces for change in the Age of Enlightenment. In France, Scotland, Germany and Russia, in London, Paris, Berlin and Saint Petersburg, they were founded to contribute to new knowledge and to ensure this knowledge reached people who could thus improve everything, from agriculture to astronomical observations. No fewer than around seventy such scientific academies and learned societies were created between 1660 and 1793.[1] In Sweden too, a number of academies other than the Academy of Sciences were founded during the 18th century. The Academy of Sciences did not originate randomly but, like the other academies, had "grown from a quite well-prepared soil".[2]

Modelled on either the London-based Royal Society or the French *Académie des sciences* in Paris, the academies were organisational collectives with similar memberships. They often enjoyed the protection of a higher authority – in the English, French and Swedish cases, their kings. Autonomy was determined through printed statutes and rules. Members and paid officials held regular meetings and published, more or less regularly, some type of series or journals. Sometimes they also ran similar projects and occasionally initiated international cooperation, which was not easy to do in an era when postal services between Stockholm and the continent took weeks, in the best case, otherwise a month or more.

IN GENERAL, in the 18th century, both scientific academies and learned societies were often a type of private authority. However, one difference between academies and learned societies was that academies were more common in countries governed by absolute monarchs, where agriculture dominated the economy, such as France, while learned societies were more common in countries that had stronger parliaments and were more likely to focus on manufacturing and trade. In a European context, the scientific academies in Berlin and Stockholm have been highlighted as an interesting middle way. They were more ambiguous assemblies and, in Stockholm's case, it was also on a geographic periphery.[3] Nonetheless, in the status hierarchy of the academies and societies, the Academy of Sciences places as one of the foremost in the 18th century, alongside those in London, Paris and Berlin.[4]

The founding of the Academy of Sciences in the summer of 1739 was thus inspired by numerous international role models. These were united through a shared faith in experiential knowledge, which has often been linked to the ideas of Francis Bacon, the English statesman and frontman of the Royal Society, about the way empirical studies of nature could increase wealth.[5] The early members of the Academy of Sciences were hardly original in their convictions about the societal importance of the natural sciences. Nor was the Academy of Sciences the first Swedish academy. The Uppsala-based *Collegium curiosorum* dated from 1710; after ten years it was given the name *Bokwettesgillet*, or *Societas Literaria Sueciae*, becoming the Royal Society of Sciences in Uppsala in 1728.[6] For *Collegium curiosorum* and *Bokwettesgillet*, as for the Academy of Sciences, so-called patriotic science was important. This entailed an emphasis on phenomena that were particularly Swedish: the cold dark winters, the light summers, the flora and fauna, as well as the northern lights, which often inspired studies of nature. Also, as regards the cultural significance of science, the scientist was seen as a "representative of his country in the shared cultural life of the Western world".[7]

So, organisational role models existed both internationally and in Sweden. The idea of a scientific academy in Stockholm had actually been formulated in 1713 by state secretary Casten Feif, in many ways the spokesman of King Charles XII.[8] At an ideological level, the Academy of Sciences was like its predecessors; it can be regarded as a bridgehead for knowledge policy in the mechanistic conception of the world that followed the scientific revolution, stretched across the 16th and 17th centuries. From this perspective, the world was as predictable as a mechanical clock, with regular movements and imperative natural laws. René Descartes and, later, Isaac Newton were famous gateway figures for this perspective and the Academy of Sciences has accordingly, and not without reason, been called "the Swedish propaganda organisation for the Newtonian sciences".[9]

As we have seen, when the Academy of Sciences was founded, it displayed clear signs of comprehensive institutional uniformity with both domestic and foreign organisations. This uniformity was equally applicable to its intellectual origins in the mechanistic conception of the world and its location in a capital city, as an organisation with elected members and with the aim of publishing a journal for findings and guidance. Nor was seeking the protection of the highest earthly power, the king, an original approach. Instead, the formative component was the actual political situation in Sweden and Stockholm after the 1738/1739 Riksdag.

ANOTHER IMPORTANT POLITICAL AND IDEOLOGICAL PILLAR on which the Academy of Sciences was built was "utilism", which emphasised the importance of science for economic reform and the benefits that could be gained from studying nature. This cult of benefit regarded economics and the application of knowledge of nature as virtues, ones that went hand-in-hand with increased domestic production and a reduced need for imports.[10] Empirical knowledge of the country, its people and its assets was regarded as something good and justified in itself, together with the perception that it could be used to refine national commodities. In "utilism", as this ideological stance was called in Sweden, benefit was the dominant basis for evaluating scientific effort, not truth or insight.[11] "Utilistic" ideas were rooted in the early 17th century, flourishing in England's Royal Society, for example, as well as other assemblies that had utility and natural history on their agendas.[12]

In Sweden this became a particularly important argument for utilising the available domestic resources, given the kingdom had lost territories in both the Baltic and in German-speaking areas in the decades prior to the founding of the Academy of Sciences. Acceptance for these ideas was not hindered by Sweden having no colonies at that time.[13] It has been noted how utilism's many demands for benefit often conflict with the idea of liberty, a tension that has been summarised as "benefit is something you require of others, while retaining freedom in your own activities".[14] This was particularly true of many people who, for some reason, included themselves in the societal elite. Liberty was for them, while utility applied to others. This perspective may appear specious, but should be understood on the basis of that era's societal hierarchy, in which different citizens best served the fatherland by making different types of contribution. Those with the rank and circumstances to study the nation's natural history, for example, should have the resources and opportunities to do so, while others should live poor lives and work hard to contribute what they could.[15]

The importance of the natural sciences as a method for increasing the nation's wealth was accentuated by the political and economic doctrines of the era, mercantilism and cameralism, which were particularly embraced by the Hats. In simple terms, mercantilism emphasised urban manufacturing while cameralism was concerned with public and national finances.[16] Together, these formed what appeared to be an almost unavoidable underlying economic chord in all discussions regarding the significance of knowledge of the natural world.[17] The role of science was that of an instrument, one that could be used to exploit natural assets that providence had bestowed upon a virtuous population. In this way, science was an important component in an overarching ideology that included the nation's assets as much as its people. These ideas gained strength because there were no opportunities for boosting national resources through military campaigns or commercial operations in Europe or on other continents.

Supporting the use of science to benefit the fatherland was thus not a doctrine confined to the Swedish Academy of Sciences. Quite the opposite, as has been mentioned, the French, English, German and Russian academies had similar dreams. But the question is whether the Academy of Sciences, despite this, went further than the others. In the 17th century, the Royal Society in London, which was in many ways a role model for the Academy in Stockholm, had propagandised for both tree planting and potato cultivation, amongst other things. But when the Academy of Sciences was founded, a good way into the 18th century, London's interest in such initiatives had faded. And in the French Academy of Sciences, more advanced science, both empirical and theoretical, was often more important than somewhat more trivial findings about how to make mortar that was not water soluble or how to avoid cracks developing in timber.[18] The same was true of the scientific assemblies in Germany and Russia.[19]

Still, it should be emphasised that the economic doctrine that was the foundation of the Academy was not particularly uniform in practice. For example, the argument for import restrictions in order to benefit manufacturing stood in stark contrast to the trade conducted by *Ostindiska kompaniet*, the Swedish East India company, with China. Here, Swedish gold and silver was traded for Chinese silk, porcelain and tea, although this did not prevent the Academy from using the company for expeditions. Also, over time, many Academy members came from the company's executive management.[20]

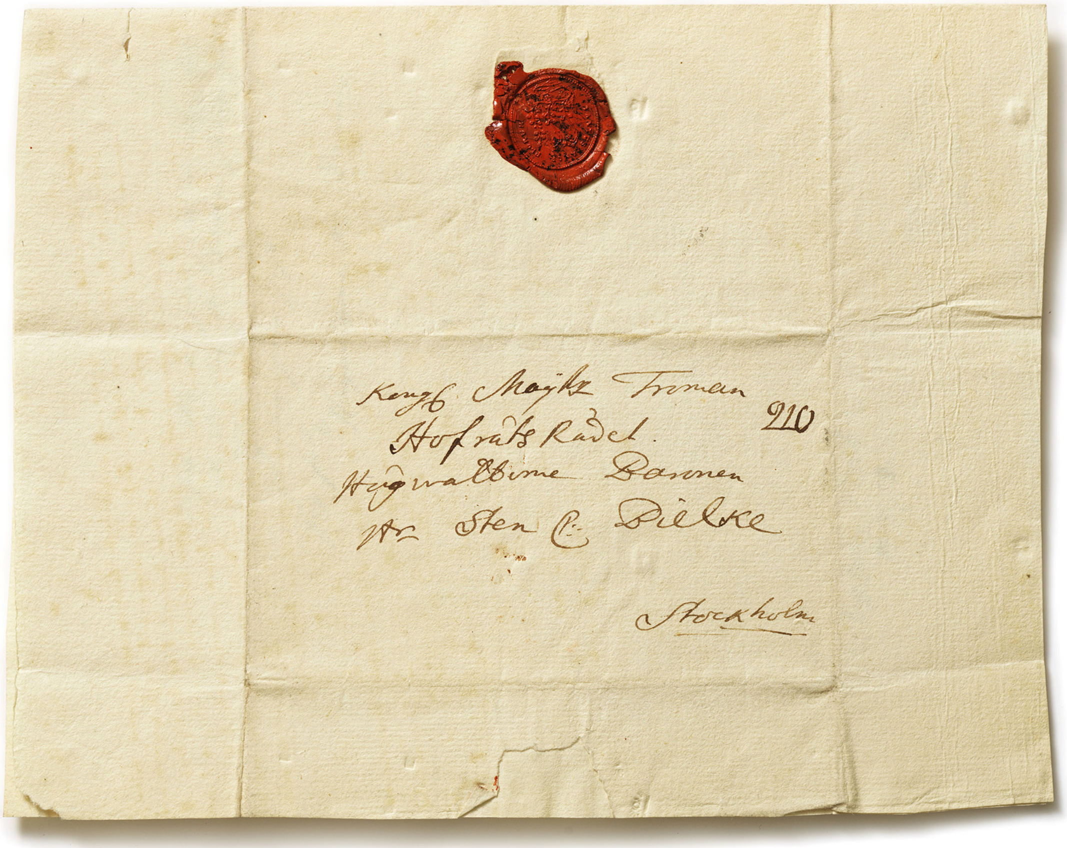
ANOTHER IMPORTANT IDEOLOGICAL BASIS on which the Academy of Sciences was founded was physico-theology: the idea that the search for knowledge in the natural sciences had religious relevance.[21] Physico-theology primarily meant that experiences of the natural world were not divided into emotional or analytical experiences; on the contrary, the spiritual and scientific aspects of an observation reinforced each other. Making inventories and conducting research were religiously motivated actions because they helped increase insight into God's creation and the wonders of the world. By extension, scientific insights allowed the more effective utilisation of natural resources, which were also God's gifts to the nation. Research may well have been regarded as a teleological argument for the existence of God, in that creation was so perfect that its creator must also be so. This idea that hardly needed to be formulated at a time when God was continually present and annual catechism hearings were a legal requirement. Anyone guilty of apostasy risked losing their head.

Patriotism, "utilism", mercantilism and physico-theology were all parts of a Swedish ideological trend that supported the study of nature and which entailed an upswing for natural history in the early years of the Age of Liberty during the first half of the 18th century.[22] At the same time, these ideological pillars that supported the Academy of Sciences reflected a morality in which actions should be based on sense, rather than sensibility, if they were to be for the public good rather than that of the individual. Actions for the public good were always based upon sense and virtue, unlike ones for individual gain, which were motivated by unbridled feeling and vice. The ideological basis of the Academy was thus not only concerned with material utility, but was equally concerned with virtuous behaviour.[23] The Academy's vision was therefore nothing less than a knowledge society built upon God's providence, for the benefit of the fatherland.

Ideas about the virtue and utility of investigating nature as regards the population's morals and the nation's wealth led to institutional and organisational support. Universities of the time were often regarded as outdated education institutions characterised by educational pedantry, with no great relevance other than possibly to young members of the nobility who had military or religious ambitions.[24] New subjects of instruction did develop during the 17th century, such as a mechanical school led by the renowned professor Olof Rudbeck, but in the end they were all marginalised or, as with Rudbeck's contribution, literally went up in flames.[25] The wave being ridden by utilistic studies of nature did break upon the universities, but with too little force to completely wash away their theological sandcastles. The influence of the church and theologians on the universities remained strong. There were successful teachers who represented and embraced the new ideas of the value of natural science: Linnaeus, Celsius and Klingenstierna. But students who were interested in subjects other than theology or law generally headed to Stockholm, where the Board of Mines or Collegium Medicum could perhaps offer a place, or why not the Board of Trade?[26]

THE UNIVERSITIES' AVERSENESS towards more radical, long-term change was seen by some as a problem in 1730s' Sweden, as it was a counterweight to the clearly ideological and significant upswing for nature studies. The Academy of Sciences was one solution to this problem. The word "academy" signals the way it could be regarded as an alternative to the universities in Uppsala, Lund, Åbo and Greifswald, because at the time they were generally known as academies. However, it should be stated that the founders of the Academy opposed this idea, explaining that the "academy" was to be regarded as a society in the French sense, not as a school. But at that time, and in the established idiom, it must have been easy to interpret this assembly as a type of educational institution. This situation changed in the latter half of the 18th century; "university" became a more common name for institutions that provided higher education and "academy" was reserved for scientific assemblies.[27]

At this time, even the Swedish word for science – *vetenskap* – became increasingly ambiguous. The older and established meaning of the word was a general name for knowledge, or awareness of a circumstance. But at the start



LINNAEUS' SEAL with his favourite flower, *Linnaea borealis*, and the Latin sentence *tantus amor florum*, "so ardent the passion for flowers". The letter on which the seal was used is dated 1746 and addressed to Sten Carl Bielke.

of the 18th century, it began to gain the meaning that we now give to it, occurring in compounds such as *naturlige wetenskaper* [natural knowledge] and *nyttige wetenskaper* [beneficial knowledge], which would now be understood as the natural sciences and applied sciences. The word *vetenskap* thus increasingly came to designate a particular type of knowledge, with expectations regarding how it was gained and how it could be used. Still, the name of the Academy of Sciences as it was understood when it was founded should probably be translated as the Academy of Knowledge, as *vetenskap* did not represent just any type of knowledge, but one that was preferably practical, beneficial, and had some occupational focus. It was really an assembly in which aspects of business policy were at least as important as the professional ones.[28] The rejected name proposals, *Oeconomisk wetenskaps societet* and *Oeconom. Wetenskapsgille*, also demonstrate how economic issues were initially seen as a vital area of the Academy's activities.

Therefore, there is good reason to regard the Academy of Sciences as the solution to a problem that arose from the success of the Hat Party in the 1738–1739 Riksdag; it created a concrete political platform for a previously established ideology, an ideology that promoted the empirical creation of knowledge about natural phenomena and their consequences for societal order as something economically and religiously desirable. The problem was that this ideology's political platform lacked an organisational structure: an office, a collegium, an academy or some other tool for organising knowledge that could promote and disseminate the gospel of the new natural science for the benefit of Sweden and the Swedes. The solution was the Royal Academy of Sciences which, from 1739, became the Hats' bridgehead for changing the circumstances of the natural sciences in the Age of Liberty. There were also networks of members within the Academy who were able to act on other political issues.[29]

AN ALMOST OVERLY EXPLICIT INDICATION of the newly formed Academy's task is the mission statement in the statutes of 1739: "All those sciences and arts that are of any real use in the public body, are subjects for the Academy's attention and consideration".[30] The assurances that new members were expected to sign testify to the same political and ideological focus:

> I, the undersigned, hereby promise and affirm on my honour, and as far as I am concerned about and care for my good name and reputation, that I will solemnly and loyally follow the rules and regulations which already exist, or which are to be drawn up by the Academy, and that my conduct will correspond with the purpose of the institution, namely God's honour, the wealth of the King and Fatherland, and the determined aims of the Academy in the origin and development of the beneficial and praiseworthy arts and sciences, not neglecting that as a useful nation's citizen, and an honest Swedish man, for my own part to contribute as much as is attainable, wherefore I will also endeavour to comply with all rules of the Academy, with effort and attention strive to improve and uphold this establishment, and to fend off all that may cause disruption, weakening or dissolution.[31]

Nor was it by chance that the Academy was located in Stockholm; this reflected its importance as a politically justified organisation, unlike the nation's four universities, especially the one in Uppsala. In particular, it was a consequence of several founders holding high political positions with Stockholm as a natural base. Premises were also available in Riddarhuset, the House of Nobility, which the nobility used for meetings when the Riksdag was in session. It can also be noted that, at this time, comparable academies were located in capital cities such as London, Paris, Berlin and Saint Petersburg.

Publications

The patterns of ideas on which many of the new academies of science were based also had practical consequences, such as gathering members in regular meetings at which new findings could be presented. Various discoveries and observations were reported in publication series, such as the Royal Society's *Philosophical Transactions*, and were thus disseminated to a wider readership. In these contexts, the language was that of the people – English, French, German or Swedish – unlike the universities, where Latin was still used in dissertations and vivas. The reason was quite simply patriotic; it increased opportunities for circulating the knowledge they encompassed to a wider group of citizens while, at the universities, Latin instead facilitated communication with a small number of similar minds inside and outside Europe. The Academy of Sciences' patriotic ambitions meant that the national language was the only reasonable option, even if foreign members could still use Latin when necessary. A requirement to understand Swedish would probably have considerably reduced this category of members.[32]

There was also a long tradition of linking living national languages with revolutionary new ideas, which was regarded as a contrast to the conservative force of Latin. After the early 16th century, this was expressed in the Christian reformation's demand that the Bible should be translated into national languages, of which the Lutheran Bible translation from 1522 and Gustav Vasa's Swedish Bible from 1526 are the best known in Sweden. It was also expressed through the publication of new ideas in natural philosophy, where Galileo's Italian texts from the early 17th century disseminated the theory that the Earth circled the Sun instead of vice-versa, finally attracting the attention of the Inquisition.

If the language issue was no great apple of discord, the choice of font for the Academy's series of publications, *Vetenskapsakademiens handlingar* [*Transactions of the Academy of Sciences*] created considerably greater conflict.[33] The question was whether the established German Fraktur typeface should be used, or whether to break the force of habit by using the new Antiqua typefaces, which many people found easier to read and required less space – an important aspect in a time when paper was the biggest expense for publication series. The fear among those advocating the Fraktur typeface was that a new one would reduce the willingness to purchase. The counterargument was that, at this point, most people could read Antiqua – "even a majority of our womenfolk and common peasantry".[34] This dilemma reflected the double hopes of the Academy of Sciences: that the *Transactions* and its relatively plentiful beneficial findings would achieve greater circulation with the Fraktur typeface, while Antiqua could provide a link to the more scholarly journals published by scientific academies in other countries.[35] The initial solution was to use Fraktur in documents for increased dissemination, but it was replaced by Antiqua after just a few years.

So, the tensions between old and new came to light even over a detail as apparently minor as the typeface used to print a publication series. Fraktur conveyed something nationally edifying and popular, while using the Swedish language and Antiqua as a communicative style represented a new orientation with cosmopolitan overtones. Representing the new was a better reflection of the Academy's ambitions, in both knowledge and politics, at a time of societal revolution.[36] As the *Transactions* were initially the main tool with which the Academy could reach beyond its own membership, the means of address were important, even decisive.

OTHER PUBLICATIONS provided by the Academy of Sciences included speeches from the Presiding Committee, given by the president, and eulogies to deceased members. However, the almanacs were more important and more widely disseminated and, as mentioned in the previous chapter, were published in plentiful numbers every year. The background was the publication monopoly that was granted to Academy in 1747.[37] Awarding a scientific academy a privilege for almanac publication was not a Swedish invention. For example, the Prussian Academy of Sciences in Berlin had an almanac privilege from 1700. The reason was that specialist knowledge was necessary to publish almanacs, and a monopoly made publication more uniform across an entire country.

Almanacs had already been published in Sweden for more than a century by the time the Academy of Sciences was founded.[38] That the Academy received this privilege in 1747 was partly due to a political desire to provide financial support for the new organisation, which was simplified due to Academy members who held political positions and had decision-making powers. Additionally, the Hat Party's control over public holidays was increased by awarding the almanac monopoly to a knowledge organisation that was loyal to the party. Political control of almanac publication was also important because the peasant estate – as mentioned in the previous chapter – opposed every attempt to reduce the number of public holidays.[39] When the Academy received the almanac privilege, it gave the country's most disseminated text – alongside the psalm book and catechism – an important publisher that was easier to control politically, because a number of members were also part of the political networks of power.

The almanac monopoly was to be the primary source of income for the Academy of Sciences over the next 225 years. A more immediate effect of this new income was the construction of the observatory, which now had financing and could be inaugurated in 1753. Incidentally, this was the same year that Sweden, as one of the last countries in Europe, abandoned the Julian calendar and introduced the Gregorian one. This reform was partially based upon an ambitious investigation by the Academy's secretary, Pehr Wargentin, in 1750.[40]

When the Academy of Sciences took over almanac publication, there was already a strong tradition of publishing lengthy informative texts in almanacs, particularly about agriculture. For example, in 1752, the almanac for the horizon of Lund published an article about beekeeping, while those for Gothenburg and Stockholm had a text about marl soils.[41] The importance of almanac publication is also evident in Wargentin's claim that farmers had more faith in the almanac than in the weather, because they tended to plan work in the fields according to the former rather than the latter.

Technology and manufacturing

The political background of the Academy of Sciences can justifiably be said to be the need for a Hat-friendly knowledge organisation. The Hat Party was happy to support manufactories – a type of preindustrial production unit that was dominated by textile production – both economically and through legislation that meant, among other things, that farmers could only sell goods they had produced themselves.[42] The remaining trade was to be managed by merchants. The Manufactory Office was also founded during the Hat-dominated Riksdag of 1738/1739, to manage the relatively extensive manufacturing support provided in the form of generous credit. These activities peaked in the 1760s, when around 17,000 workers were employed in manufactories in Swedish towns and cities. They often gathered people who had been taken into custody pursuant to vagrancy laws, or other minor crimes. Conditions were often appalling but, as long as the Hats were in power, manufacturers enjoyed comprehensive support.

Manufacturing was also something, along with art, that was mentioned in the very first statutes of the Academy of Sciences as one of eight particularly important areas for this new assembly. In this context, manufacturing should be understood as the manufacture of goods or as production in general, just as art was equivalent to the contemporary concept of technology. At that time, artisanry and manufacturing were activities linked to knowledge in politically leading circles. The Academy was the knowledge organisation that was to ensure improvements in manufacturing, making it more efficient by increasing the circulation of new knowledge in relevant areas of society.

Naturally, this was associated with the utilistic and mercantilistic thinking that beneficial knowledge promoted domestic manufacturing which, in the best case, could go to foreign markets and limit expensive imports. It thus aimed to support a trade surplus by demonstrating frugality and moderation in spheres where societal norms required them, while also enjoying the abundance that providence made available within the nation's borders.[43] All that was needed was to survey the country's resources and to exploit and process them. This was done through inventories of everything from people to minerals, through breaking new ground, planting new forests and importing new methods of production rather than finished goods, such as the famous attempts to cultivate silk in Sweden, or by developing surrogates for various imported goods.[44]

ECONOMIC ISSUES were also discussed at the Academy of Sciences. The best known and most widely written about was founder Anders Johan von Höpken's speech in 1740 on the benefit of luxuriance, or the advantages of luxury consumption, an issue that was discussed pretty much throughout the Age of Liberty. The basis of this discussion was the view that virtuous consumption was characterised by moderation. It should not be too prolific, nor too fastidious. Because different sections of the population had varying assets, richer people were to display their virtue by consuming some luxury items, not least to mark their societal status, while those who were poorer were expected to be more frugal in their consumption. There were both economic and moral arguments for such an order – moderate consumption increased demand by the right amount, but also maintained the perfect dose of values such as diligence, thrift and patience.[45]

ESSAY
The rank and file of the Academy of Sciences
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More concretely, no attempt at surveying, exploiting or refining the nation's resources was too small to be ignored by the Academy. Treatment for bedbugs and a fern soap were worth as much as methods for making Smålandic cheese and birch syrup. Some areas have received particular attention. Textile production, which was a purely manufacturing activity, gave rise to numerous findings that were presented to the Academy and circulated in its *Transactions*. This was definitely circulation and not dissemination, because much of the published advice was submitted by non-members. Contributions came from school teachers, vicars or officers, as well as from landowners, farmers or manufacturers – a cross-section that reflected the subscribers, whose participation in the contents could include how to bleach yarn or process linen. In the field of householding, there were findings about baking ovens and cellars; a Russian type of icehouse received special attention in the end of the 1740s.[46]

FROM THE PERSPECTIVE OF OUR ERA'S EXCESSES, it is very clear how many of these findings were based on the sparse resources available for

A BOX OF RAW SILK from Berzelius' collection. Silk was an expensive and desirable luxury that many people hoped could also be produced in Sweden.

self-sufficiency. One invention in this genre has become a primary symbol of this: Papin's digestor, which was enthusiastically developed and launched by the Thamic lecturer at the Academy of Sciences, Johan Carl Wilcke. He was charged with managing the Thamic lectures at the Academy of Sciences from the end of the 1750s, as described in the previous chapter. After reading mathematics and physics in Uppsala in around 1750, Wilcke had studied abroad, including in Göttingen. He was a skilled experimental physicist and was best known as an interpreter of various electrical phenomena, including thunder, an area in which he was something of an international authority.

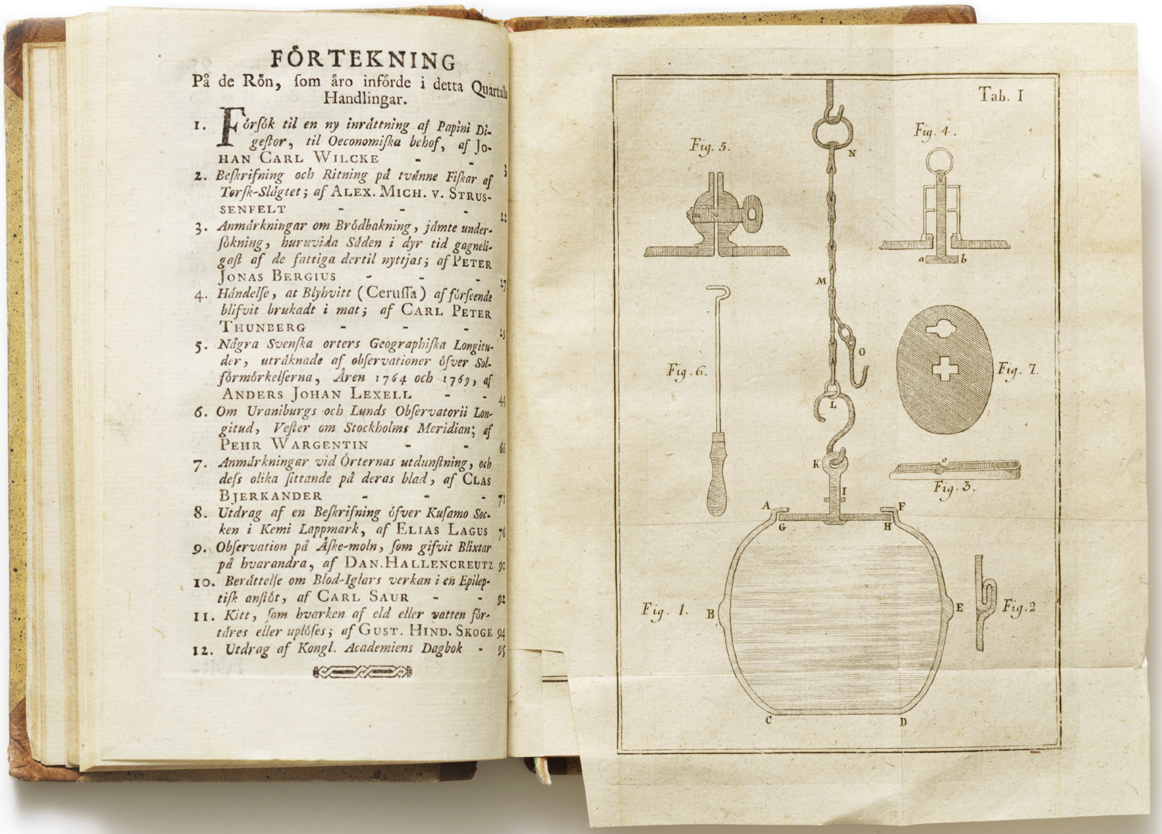
However, his name has come to be associated with a completely different phenomenon, namely a pressure cooker. It all started in the 1680s, when the French inventor Denis Papin described an apparatus that could be used for cooking food, even on the bone, and foodstuffs that were otherwise not utilisable in the kitchen.[47] This instrument became known as Papin's digestor. It appears to have had a renaissance in the 1760s, when there was a new drive for its use in France.

In Sweden, the pressure cooker was discussed in the Academy of Sciences after the secretary had presented how it could be used to prepare "delicious hearty soups". Some members became interested and started lobbying for the Academy to start boiling bones for the city's poor. In the spring of 1762, the Academy had foundry director Gerhard Meijer produce a Papin pot for trial use, but this turned out to be complicated and difficult to master. Wilcke therefore constructed a simplified version a few years later and, it is said, this worked so well that Wilcke used it at home to prepare both chicken soup and beef tongue.

In the spring of 1773, Wilcke published "Trial of a new version of the Papini Digestor, for Oeconomic needs" in the *Transactions*, in which he described its workings.[48] It consisted of an oval copper container, with a simplified lid that closed tightly to hold the pressurised steam inside. The entire device was hung above the fire by the lid, which was held firmly in place thanks to the weight of the container and its contents, even before it was heated. Wilcke stated that with his version of "Papin's digestor", he had

> with the best of success, not only fully cooked the toughest Beef for an hour, but also transformed the hardest bone to tender calcium, and thereby produced a delicious and hearty Soup, which in the cold [the article was published in the January issue] set to jelly, but which on a stronger heat could have become so overcooked that it would be browned, have a burned odour and have always remained a thin water.[49]

Things could also go very wrong: "The worst thing that could happen to these Digesteurs would be that the Copper somewhere ruptured, and the fluid would be lost in a stream of hot vapours".[50] However, Wilcke promised



USING A FRENCH MODEL, Johan Carl Wilcke published a design for a pressure cooker in the *Transactions in* 1773. At an earlier date, the Academy had asked a foundry director, Gerhard Meijer, to produce a Papin pot for trial use (see picture to the left).

that "there is no risk of a total explosion, such as with cast metals". It is easy to see that this innovation, despite the risks, was well worth trying on a larger scale. Wilcke asked rhetorically: "How much nutritious food is trodden daily beneath our feet, with which many poor mouths could be fed?"[51] A general announcement was made next to the article in an attempt to answer this question:

> The Royal Academy of Sciences wishes, that one or another person in the City and on each Island in Stockholm will undertake to gather Bones, acquire such a Pot that is here described, carefully practise its use, and thus cook Hearty soups for sale. Each and every one of these people would probably then have their own business, and many poor mouths be fed for a few pennies.[52]

We know that a number of burghers did order Wilcke's digestor from the city's coppersmiths,[53] but how successful sales were for this hearty bone soup is more uncertain. Still, the example of Wilcke's digestor demonstrates how the Academy of Sciences attempted to make the use of resources in 18th-century Sweden more efficient. Nothing should go to waste. Everything should be processed and reused. Bones that had been scraped clean were now to be boiled into a nutritious soup, for the delectation of the poor

Thrift and efficiency

Wilcke's trials are a clear sign that the knowledge circulated by the Academy of Sciences invoked a sustainable society, at least for people of lesser means. However, the aim was not to tread softly upon the earth. Instead, thrift should be promoted as a virtue among the peasantry so they did not devour the fatherland's God-given natural assets. In those times of sparse resources, not even the urine and faeces of people and animals were to be wasted; they were used for manufacturing saltpetre which, in turn, was necessary for domestic production of gunpowder.

ANOTHER ISSUE discussed in detail at the Academy of Sciences was how to use less wood. During the Age of Liberty, there was widespread worry that Sweden's forests were being felled at a greater rate than they could regenerate, and a lumber shortage was a constant threat. This was serious because substantial amounts of wood were required to produce bar iron, which was Sweden's most important export, as well as tar and timber, other important products for foreign trade.[54] The forest was a truly invaluable resource because it provided construction material and fuel for cooking and heating. Society in the 18th century was completely dependent on wooden raw materials, so it is no surprise that the Academy of Sciences presented prize questions about the best way of solving the looming problem of a wood shortage.

Even outside the context of these prize competitions, numerous solutions were proposed, with more efficient silviculture as one way of dealing with the situation.[55] Another way was to save wood in various areas of its use. Interestingly, a relatively large proportion of the articles published in the *Transactions* between 1739 and 1815 dealt with how to increase the use of alternative sources of heating or how to develop entirely new ones. These types of studies declined from more than ten per cent in the *Transactions* in the 1740s to just a few per cent in the 1750s, before reaching new heights at around five per cent in the 1760s and 1770s, and the same again at the start of the 19th century.[56]

In comparison, relatively few articles covered how wood consumption could be rationalised in mining and other production activities, such as tar

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distillation or saltpetre crystallisation. The reason was that Academy members mostly espoused wood-saving measures in fields they could observe themselves, as Stockholm residents with a high social status and from the higher estates. This entailed ideas for more efficient tiled stoves and studies of how peat could be used instead of wood for cooking, despite most timber being used in mining and for wooden products.[57]

OTHERWISE, THERE WERE NUMEROUS FINDINGS and results for how various products could be adapted to make them more sustainable or how production methods could be made more efficient. Uppsala chemist Johan Gottschalk Wallerius performed trials that showed that lime was to be preferred in mortar, rather than mussel shells or eggshells.[58] Almost twenty years later, Wallerius' successor as professor of chemistry at Uppsala, Torbern Bergman, described a method for improving beekeeping.[59]

The most striking of all the proposals in this genre is perhaps the Academy of Sciences' reward of 6,000 daler in copper coin to the person who provided the best way of storing gunpowder in gargousses – fabric bags of gunpowder that were primarily used as artillery charges. This initiative and the reward came from the King in Council, after a proposal by the Secret Committee of the estates. Gunpowder storage was an important issue for military contingencies, because it slowly became unusable due to damp, or was destroyed considerably faster and more dramatically in case of fire. A method that used lacquered cartouches was submitted by Master-General of the Ordnance Reinhold Anrep, but did not pass the tests performed at Ladugårdsgärdet, a military training ground just outside Stockholm. A new proposal was submitted in 1774, by Miss Maria Christina Bruhn, who also advocated lacquered cartouches. There was no reward this time either. Instead, seven years later, a third similar proposal came from a nobleman, Major P. G. Wagenfelt, who was rewarded with 500 riksdaler specie. This resulted in a battle over priority, in which the Academy of Sciences backed Miss Bruhn who, in 1787, was finally able to receive her share of the reward. However, for some reason this had been reduced to just over 166 riksdaler specie.[60] These types of drawn-out conflicts and extensive examinations of priority for the rewards and prize questions were, unfortunately, not unusual.

Chemistry made particular progress during the 18th century as a foundation for improving various forms of production, not least the manufacture of raw materials, such as alum for textile mordants, potash for making glass

ILLUSTRATION TO A FINDING about tiled stoves by Johan Anders Nordenberg, published in the *Transactions in* 1739. The picture had to share the page with a poisonous monk's-hood plant to save on the expensive copper plates.

Wenbock Akerbrukets framsände . . 469

Tab. II.


Fig: 1.
1 2 3 4 5 6 7 8 9 Qvarter.
C. Bergquist sculps.

and soap, and saltpetre, which was the main ingredient in gunpowder.[61] At this time, chemistry was a science in which theories and methods were undergoing rapid development, shown through chemists' increasing skills in isolating substances. Acceptance of a mechanistic conception of the world in chemistry created an understanding of many different reactions and processes. This could be seen through the slow marginalisation of alchemy at this time, a process in which the Academy of Sciences was one of several arenas.[62] Initially, success in chemistry was not particularly associated with better laboratory equipment, because more precise scales and thermometers only started to have an impact at the end of the century.[63] Instead, new insights were acquired by utilising changes in the mining industry and in the production of chemical raw materials.[64] However, it was only in exceptional cases that chemists, despite their increasingly advanced theoretical reasoning and better understanding, were able to provide suggestions for better methods of alum production, for example.[65] Production processes in mining, in forests and outfields remained more important for the chemists' potential development of new knowledge than their findings were in the development of new production methods.

Improvements to agriculture

Generalising conclusions about the relationship between the understanding of chemical processes and the rationalisation of different kinds of chemical production can be beneficial. Even if the Academy of Sciences overflowed with advice and suggestions for how industry and manufacturing could be improved and made more efficient for the benefit of the nation, only a few of these were based upon systematic empirical studies or theoretical models. This was particularly true of the efforts invested in improving agriculture. In agricultural mercantilism, no plant appears to have been too small, no plough construction too obscure, no soil mix too strange to be brought up and discussed. Sometimes this advice could be so highly valued that it led to an article in the *Transactions* for more general circulation among farmers. Here, however, it should be noted that this publication's print run was about 500 copies, at least until the 1780s, significantly fewer than the more than 100,000 almanacs that were distributed throughout the country every year at that time, and which were certainly read by even more people.[66] Selected findings from the *Transactions* were also read from the pulpit. This increased circulation, but hardly to the levels of the almanac.[67]

It is well-known that the Academy of Sciences was initially dominated by an interest in agriculture. Actually, in its early years, some people regarded the Academy as a purely agricultural academy.[68] Ten to twenty per cent of the articles in the *Transactions* were dedicated to agriculture.[69] Much of the advice in the almanac also related to this, which seems natural given its intended readership; this could be anything from new types of ploughs to the best manure for a particular crop or how to convert land for agriculture, a subject that frequently included the ditching and cultivation of heather heaths and southern Sweden's sand dunes. In 1775–1783, the Academy of Sciences also published a series dedicated to agricultural economy, which became relatively popular.[70] This included a variety of submitted essays and answers to various relevant prize questions from the Academy.

The interest in agricultural issues is linked to a political-ideological climate – where agromania was described as the highest intellectual fashion of the 1760s – and increased practical opportunities for large-scale agriculture using new methods of cultivation and better equipment.[71] However, many observers feel it is unrealistic to call the various agriculture-friendly elements of political reform in late 18th-century Sweden a comprehensive programme of economic policy, one that was founded on a view of agriculture as the primary source of the national economy.[72] In Sweden, this was not systematic work that followed strictly established lines, such as in the French theory of physiocracy. Instead, there was a political debate with many elements that were advantageous for agriculture. This also resulted in numerous concrete measures that strengthened the position of farmers and agriculture, especially after Gustav III came to power through a *coup d'état* in 1772, thus ending the Age of Liberty. The people who particularly benefitted from these reforms appear to have been large-scale farmers and squires who could benefit from the slow but continual increases in the price of land throughout the 18th century.

THE ENTHUSIASM FOR PROMOTING AGRICULTURE, in any kind of possible or impossible manner, was thus visible in the primary activities of the Academy of Sciences in the Age of Liberty and in the Gustavian era, 1772–1809, in its publications and in the prize questions. Both the *Transactions* and the almanacs published advice on improving meadowland or how organic materials could be combined to replace the constantly lacking and lauded manure. Another favourite subject was how to avoid pests – as much insects as rodents, perhaps primarily moles and field voles. This was natural, bearing in mind the zoological expertise of the Academy, which had members such as Linnaeus. Additionally, there were numerous prize questions on everything from Sweden's soil types and cultivating root vegetables or animal feed, to ideas about how to avoid unnecessary seed wastage, something estimated to amount to one-third of the country's rye harvest.[73] Finally, a proposal for how to use a sickle to minimise waste was rewarded. It was also possible to reward contributions made outside competitions, such as the one for an improved threshing machine used to remove seeds from stalks and husks.[74]

Another way of circulating knowledge about agriculture was the publication of a guide to arable farming, *Åkerbruks-Cateches* [Arable Catechism], which was a free translation from Danish that was typical of the times, but with additions and amendments for Swedish conditions. The Academy purchased three hundred copies of the guide, which took the form of questions and answers, and distributed it for free in rural areas. It was also translated to Finnish and published as a series in the almanac for Åbo, then part of Swedish territory in what is now Finland. There were many clever tricks for circulating information about better agriculture for the enlightenment of the peasantry.[75]

While a great deal of attention was paid to various new plants, how meadows should be managed, different soil types and how to fertilise soil with other materials, primarily marl, which was considered the best fertiliser, great efforts were made to mechanise agriculture. The Academy invested a significant amount of energy in evaluating and testing various mechanical inventions for agriculture, such as ploughs, seed drills and threshers. There were also different versions of mills, entries in the apparently invigorating contest between horizontal and vertical sails or blades. The Academy of Sciences sometimes acquired new constructions to study them in more detail and, in the best case, improve them.[76]

These machines and devices generated more examples for the instrument collection that was stored at the Academy of Sciences' observatory in Stockholm, at least the models and constructions that were relevant to agriculture, as these were often among the bulkiest ones. Many met the same fate as many other instruments when they were transferred from the care of the Academy of Sciences to the Royal Chamber of Models before, in the early 19th century, ending up with the Academy of Agriculture – but more about this later in the chapter.

One subject that the Academy held particularly dear was apiculture. Honey was by far that time's most important sweetener and was a product with relations to both agriculture and manufacturing, which should have appealed to the Academy of Sciences. There was also the symbolism of the bee as busy and useful, and idea of the industrious bee strengthened the association between beekeeping and manufacturing activities. In the 1770s, when the Academy awarded prizes to people who best fostered apiculture, they went to people with high societal status, such as vicars and parsons, officers and magistrates.[77] Farmers and others from the peasantry need not bother.

Other agricultural subjects that were important for manufacturing and more centralised societal functions included pearl farming, which was also the subject of a number of essays in the *Transactions*, although the mussels that produced the pearls were, for some reason, not surrounded by the same symbolism as bees. Another agriculture-based industry of great interest to royalty was the oak plantations, which were vital to the Admiralty because the time's most advanced military equipment, the warships, was oak-timbered. This was complicated by tanners also needing oak. The bark, rich in tannins, was just as important for tanning leather as the timber was for building warships. The Academy of Sciences tried, almost obsessively, to determine the extent to which oaks could be debarked without harming the quality of the timber.[78]

OVERALL, THESE EFFORTS to help agriculture and silviculture led to hardly any decisive improvement in returns. Instead, the significant increase in grain production in the 18th century has been explained by the expansive new cultivation resulting from the subdivision of homesteads which, in turn, was a consequence of population growth. Calculations have indicated a 75 per cent increase in agricultural production from 1720 to 1815, which is actually equivalent to population growth in that period. This also allowed Sweden to move from importing grains at the end of the 18th century to exporting them in the 1820s.[79]

Bearing in mind the members' backgrounds and the almost total lack of representation from the peasant estate, it is no surprise that the Academy of Sciences almost routinely embraced the Age of Liberty's almost ritualistic view of how more efficient agriculture spread from landowners and the nobility to reluctant farmers. People of a higher rank and societal position were included in an ideal of virtue, in which they represented a new type of more efficient and improved large-scale agriculture that used new methods and technologies, while the rural population were generally regarded as lazy and unwilling to change their outdated methods. The gentry represented active change, in contrast to the conservative passivity of the peasantry.[80]

Naturally, the Academy of Sciences' agricultural activities were influenced by these more general attitudes and perspectives. Members preached to each other orally and in writing, thus confirming their own initiatives for the introduction of new and efficient methods and plants on manors and large farms. The circulation of findings outside this sphere was, as mentioned, primarily achieved using the almanac. However, even if representatives of the peasantry did manage to read through an article in the almanac, a huge step remained between there and putting one of these well-meant suggestions into practice. Expectations appear to have been low that advice in the almanacs or *Transactions* would break the peasantry's attachment to tradition and its antipathy to the equivalent changes in village committees and subdivided farms, even if prizes and medals were also awarded to simple farmers who had proven to be innovative or otherwise more hardworking than most. The comprehensive and polyphonic – in terms of subjects – agricultural literature of 18th-century Sweden appears to have described various agricultural novelties, rather than initiating them.[81] The result was a very limited circulation of new ideas, more a type of reporting within the Academy of Sciences and to other agricultural enthusiasts in the capital about attempts being made in various areas of Swedish agriculture.

HOWEVER, ONE THING THAT COULD NOT BE INFLUENCED or improved was the climate. The issue of the advantages and perhaps disadvantages of the weather for Swedish and Finnish agriculture and society in general were discussed in depth and, in 1764, formed the basis for one of the Academy's prize questions. The answers had the same approach as other contributions to the debate, namely absurdly upbeat references to positive aspects of the northern climate; how snow provided transport opportunities and cold winters fostered manliness and capability. The dominant medical theories of the time stated that infections arose and were spread through "bad air" – miasma – such as from standing water or rotting organic material, something that cold fortunately counteracted. That cold air prevented infection was, naturally, welcomed by Swedes and other Nordic peoples. In other words, the Nordic climate had a positive effect on both people and the economy. This type of thinking was widespread throughout the 18th century, becoming of even greater significance towards the end of the century and long into the 19th century.[82]

There were also hopes of cultivating foreign plants in Sweden for economic purposes. These suggestions were often quite reasonable, such as the idea of introducing buckwheat and fodder grass from Siberia, as well as the original American potato. Trees and herbs could be brought from mountainous regions such as the Alps, the Pyrenees and Scotland. But there was also room for a more naïve optimism, such as the great expert Linnaeus' hopes of cultivating saffron in the Swedish mountains, an opportunity that "should not by us be left untested".[83] Other plants of great economic value were those that could be used for dyeing textiles. Among ones that could be grown in Sweden, substitutes for the expensive imported plant dye indigo and the colorant cochineal were searched for again and again, not without success but not with fully satisfactory results either.[84]

Increased competition

Despite all the aims and efforts of the Academy of Sciences, throughout the 18th century there were parallel discussions on the establishment of an agricultural organisation that could introduce new and improved methods. The problem was that agriculture had such a great geographic range and that many small farmers, both landowners and those who worked land owned by the crown or the nobility, were illiterate. The potential for reaching out to a broader societal layer in rural areas was extremely limited in the 18th century. Attempts using almanacs, arable catechisms and other ways of circulating findings and advice were not enough.

Among the proposed agricultural organisations that would promote the circulation of knowledge, was one from 1717: Christopher Polhem's ideas for regional rural collegiums, put forward more than twenty years before the Academy of Sciences was created. Two years after the Academy was founded, in 1741, the idea of an Economics Collegium was launched; this would be a more centralised part of the state apparatus, organised like the Board of Trade or Board of Mines, so creating an expert body for controlling and improving activities. An organisation was launched during the 1751/1752 Riksdag, built upon local parishes that formed regional provinces led by governors and run by the newly established *Ständernas lantbrukskontor* [Agricultural Office of the Estates] which, in turn, was to maintain close contact with the Academy of Sciences. Similar proposals recurred in 1756, 1761 and then more or less regularly until a few decades into the 19th century. This repeated geographical-hierarchic organisational plan was similar to that realised in the early 19th century, with rural economic societies that were components of the Academy of Agriculture.[85]

However, before a more considered national proposal came to fruition, a purely agriculturally focused society was formed in 1766: the Patriotic Society. This started gaining steam in the 1780s, publishing, for example, a *Hushållnings-Journal* [*Journal of Economics*] from 1776. The Patriotic Society had sprung from the Pro Patria order in the 1760s, when the Academy of Sciences had a somewhat more restrictive admission policy for new members, which appears to have encouraged the creation of the Patriotic Society. Initially, membership of both organisations was not particularly common, indicating that the Society satisfied a need among those who had not been accepted as Academy members.[86]

In some senses, the Patriotic Society can be said to have taken over some activities from the Academy of Sciences. An attempt at a stricter division was made at the start of the 1770s, when the idea was that the Society would dedicate itself to general economics, in practice historical, political and economic perspectives, while the Academy would keep practical findings on its table. However, in the latter half of the 1770s, this division of labour no longer appeared to stand, particularly as the Patriotic Society and its journal also began to circulate knowledge about improvements to current agricultural methods to a more or less cooperative peasantry.[87] This competition was perhaps particularly noticeable in the idea of publishing a dictionary of rural economics, which was discussed in the Patriotic Society in the mid-1770s.[88] Overall, it can be said that the Patriotic Society was institutionally similar to the Academy of Sciences, as its members promoted the circulation of knowledge in agriculture at its meetings and it published a journal and other writings.

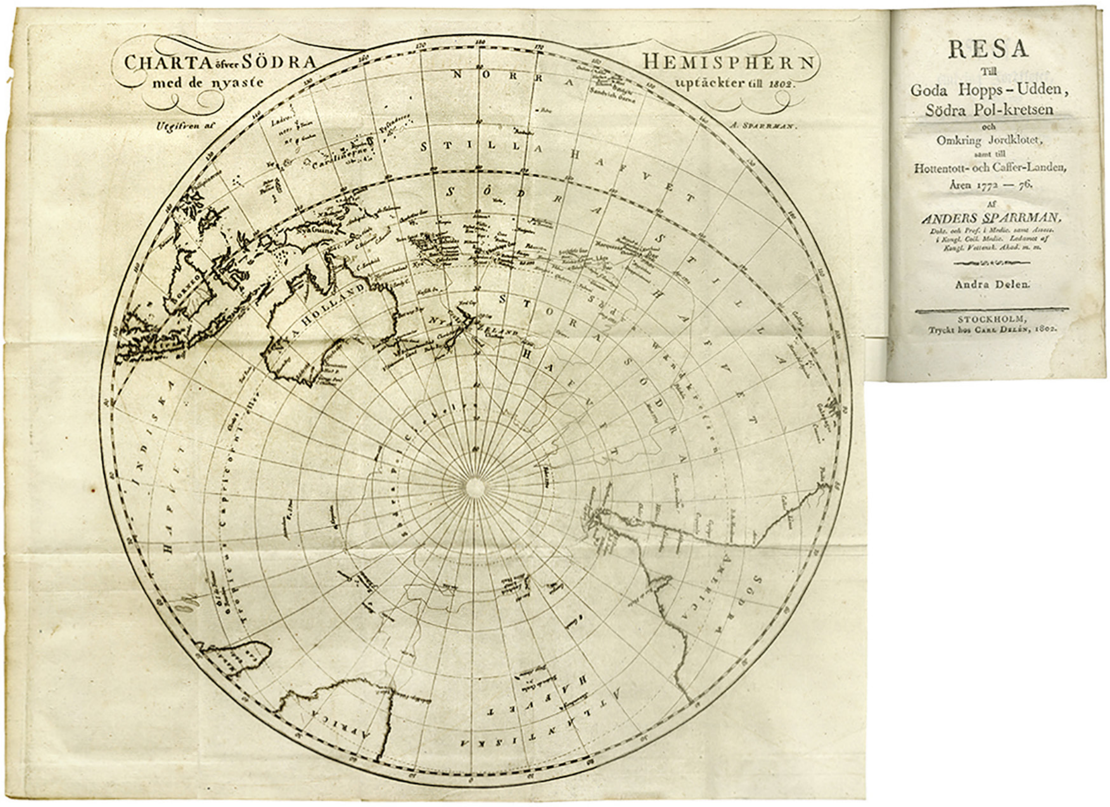
Meanwhile, in the 1780s, interest in agricultural issues began a slow decline at the Academy of Sciences, perhaps as a result of the Patriotic Society becoming increasingly active in various ways, such as publishing *Hushållnings-Journal*. In the decades around 1800, the position of the Academy further weakened due to greater interest in the arts and culture in the nation's leading political circles, at the expense of the promotion of agriculture, science and technology. New political circumstances also resulted in new or less institutionally uniform assemblies which, to some extent, competed with the Academy of Sciences and its position as a knowledge organisation. In this context, as well as the Patriotic Society, the following organisations were founded: the Swedish Academy in 1786, the *Svenska krigsmannasällskapet* [society of soldiers] in 1796, which was renamed the Royal Academy of War Sciences in 1805, and the Royal Academy of Agriculture in 1811. At the Academy of Sciences, the last prize question on the theme of agriculture was issued in 1808; this was about the conditions that should apply when introducing crop rotation.[89]

Surveying the realm and its population

The survey projects that involved a number of Academy members were intimately associated with the Academy of Sciences' enthusiasm for agriculture. The best known of these are probably Carl Linnaeus' various regional travels, first the one to Lapland in his youth, then the trip to Dalarna with his students and, even later, the trips financed by the Riksdag to Öland, Gotland, Västergötland and Skåne. Linnaeus' regional travel and his students' expeditions in Europe and to foreign continents have been described as a personal scientific method just as much as a career move.[90] Naturally, they also resulted in numerous articles in the *Transactions*.[91]

The Riksdag's financing of the various regional travels undertaken by Linnaeus in the 1740s was linked to its interest in surveying the nation's resources with the aim of better utilising them.[92] Descriptions of his travels were also published so that their findings could benefit others. These types of trips, for the purpose of inventorying and publicising resources and assets in different areas of the country, were in no way the invention of Linnaeus. In the 1730s, the Board of Chancery had encouraged the publication of descriptions of different areas of the country and their customs, but travel as a means of systematic investigation and inventory is naturally hundreds of years older than this.[93]

Accordingly, in December 1739, Mårten Triewald proposed that the Academy of Sciences should send out travellers to the Swedish provinces to survey and



FRONTISPIECE TO ANDERS SPARRMAN'S BOOK about his experiences on James Cook's second expedition, 1772–1776. The route is marked with an extremely thin line and can just be seen as it weaves around Antarctica.

explore the country's natural history and discover hidden resources. However, this proposal was stopped due to a lack of money, and the Academy did not organise any domestic travel focusing on natural history until several decades later; the first was a journey to Lapland in 1780. Then there was another break until the end of the 1790s, when a more lasting change finally occurred.[94] So, there were relatively few domestic travel projects in the 18th century, despite Linnaeus' arguments for them, something that may have been most strongly expressed in an instruction for travelling nature researchers that he presided over in Uppsala at the end of the 1750s.

When the issue was raised in the Academy at the end of the 1790s, it regarded a proposal to establish travel stipends for domestic natural history trips, which would be balanced by the benefits to knowledge about the fatherland's natural history and economy, provided that the local population in

different parts of the country, particularly northern Sweden, could be encouraged to submit information and specimens to the Academy. Such support could be designed to reward well-documented and knowledgeable locals using the "correspondence model", which was based on local residents submitting observations and material to document knowledge of their own region. The proposal was well-received, and funds were granted to employ a pastor and a curate to collect specimens in northern Lapland. Their efforts were evaluated a few years later, but with somewhat ambiguous results.[95]

Instead, interest was increasingly focused on the exotic foreignness of other continents, to which various Linnaeus apostles were sent on more or less hazardous voyages of discovery. They frequently went east, on ships sailing under the flag of the *Ostindiska kompaniet*, the Swedish East India Company.[96] The best known in the context is the apostle Anders Sparrman who, on returning from journeys in China and to the Cape colonies of southern Africa, was elected to the Academy after being nominated by Linnaeus. He was later employed to organise the specimens he had brought home and the collections of the Academy of Sciences; their development is described in more detail in the next chapter.[97]

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A museum to enlighten the curious
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THE ACADEMY OF SCIENCES REMAINED central to national surveys during the 18th century and afterwards. One of the earliest elected members was land surveyor Jacob Faggot, an employee of the Land Survey Board, who published his widely used instructions for parish descriptions in 1741. These had not been created in a vacuum; Faggot had been inspired by the county governors' reports that, from 1735, were to be submitted to the estates before every Riksdag – yet another sign of the interest in the assets of various regions and knowledge of how industries were developing.[98]

Parish reports were regularly published among all the other advice and findings in the *Transactions.* The Land Survey Board's economic surveys of Finland, among others, were a significant part of the information used in the agricultural land reforms conducted towards the end of the 18th century and in the 19th century.[99] Nor should we forget that taxation was largely based upon land ownership at this time, with homesteads as the smallest taxable units. With a taxation system where taxes were largely paid in kind and calculated on the production capability of a farm in units of land, economic and geographic descriptions were obviously decisive in the assessment of a parish's ability to pay tax.[100]

LINNAEUS APOSTLE DANIEL SOLANDER with a flower and a botanist's knife. This copperplate was part of a series of very popular caricatures of *macaroni*, the precursors to dandies, produced by Mary and Matthew Darly in 1770s' London.

ANOTHER IMPORTANT ASPECT of taxation and other activity to boost the economic wealth of the fatherland was knowledge of the population. Here, the Academy of Sciences was as far ahead as it was with the parish reports, and the issue of drawing up lists of mortality rates was discussed in June 1741.[101] An important issue in the mid-18th century was the amount of emigration. Too much of this was something of a nightmare scenario in a time when depopulation was a threat and "a numerous peasantry [...] a Country's most vital wealth and foremost strength".[102] These ideas were in line with the mercantilism of which we have already seen so many examples. As regards the population, it should be as plentiful as possible, because a god-fearing and hard-working citizenry of the right Swedish character were considered a source of national wealth. The more the better, at least up to levels that were far above the estimated multitude.[103]

Even if the Swedish population had been previously calculated through tax lists and church records, during the 1730s and 1740s it became increasingly pressing for the political powers to know of the size of the population, as well as its distribution across various categories, such as men and women.[104] The country governors' reports, regulated by the King in Council in 1735, were also to include changes in population. There was also a proposal for more detailed reporting on population numbers during the Riksdag of 1735. This would allow proper calculations of the population, instead of making estimations with calculation methods.[105]

However, it was not until the 1740s that any great effort was put into population statistics, or political arithmetic as it was then called. As usual, the inspiration came from abroad. England, Germany and the Netherlands had all made attempts to estimate the size and condition of their populations. These efforts were well-known within the Academy of Sciences which, during the 1740s, became central to organising attempts at a census, apparently in large part through its secretary, Pehr Elvius. He was famed as a skilled mathematician and published an essay on the subject in the *Transactions*, based on church records from the past fifty years. But the Academy of Sciences soon acquired more comprehensive national material by gathering excerpts from the county governors' reports that were submitted prior to each Riksdag, and which Elvius used for the first calculation of the total population of Sweden and Finland, as well as the age and sex distribution.[106] The study was presented to the Academy of Sciences in 1746, but was not published in the *Transactions* as the result – around 2.1 million inhabitants – was considered challenging for national security. However, the more optimistic estimation by Uppsala professor of economics Anders Berch, which was 2,990,000 inhabitants, had no problems getting past the watchful eye of the censors.[107]

During the 1746/1747 Riksdag, its most powerful body, the Secret Committee, discussed the potential for creating an organisation for population statistics, for the continual collection of data about births and deaths, ancestry, sex and estate. For deaths, the causes should be stated, and for births, whether the children were illegitimate or legitimate. The idea was that the pastor of every parish should send information to the diocese and then to the county, so that tables could be compiled for the entire country. This numerical material could then be processed by the Academy of Sciences and the Collegium Medicum, apart from information about population numbers, which were to be confidential and only available to the King in Council. It should be noted that several members of the Secret Committee were also members of the Academy of Sciences, a circumstance that may have facilitated discussions.[108] After having drawn the conclusion that this knowledge could be used to calculate a taxation basis and a great deal else, the estates accepted the proposal for an organisation that collected population statistics. The decision was taken to ask the Council of the Realm and the King in Council to ensure it was realised.[109]

Surveys were soon printed and distributed to clergy in all parishes in Sweden and Finland, which was then eastern Sweden, but not in Swedish Pomerania. The idea was that the clergy would fill in the information by consulting church records and forward it for collection and compilation – an example of a fairly advanced form of knowledge circulation, aided by the well-oiled organisation of the church. However, this turned out to be more difficult than expected because there were no columns for deceased widows and widowers, for example. The categories labelled born and christened also created uncertainty. At the 1752 Riksdag, the pastors complained about these problems and the comprehensive information they had to submit every month. But work continued, and the information was sent to the Board of Chancery, where a statistics committee had been established with members of the Academy of Sciences, including Jacob Faggot and the new secretary, Pehr Wargentin.[110] They soon discovered that the information they received included numerous errors; it just didn't add up. However, for its time, it was one of the most ambitious census projects ever.

THE FIRST GENERAL TABLES on the state of the population were presented at the end of 1755. Two depressing facts became apparent in the Secret Committee's state delegation: the high mortality and the high level of emigration. Mortality obviously required work by physicians and new approaches to healthcare, especially regarding the neglect of small children. Emigration was soon a word on everybody's lips. The problem was the annual outward migration of 6,000 to 7,000 people of working age. Twenty-five years later, when Wargentin went through all the population tables for 1750–1773, he discovered that this conclusion was based upon erroneous data.[111]

However, the results were assessed as extremely valuable and "not without particular pleasure due to the important information, which is to be thereof collected, and over this excellent institution, the like of which no other Nation yet possesses", as the Secret Committee phrased it.[112] The committee considered the tables so useful that they proposed establishing a public authority, the Central Statistical Commission, which was founded in the autumn of 1756. The commission thus became Europe's first public authority for statistics. All its members were also members of the Academy of Sciences, which had promoted both the statistics system and the commission, not least through articles in its *Transactions*, such as Secretary Wargentin's "Anmärkningar om nyttan af årliga förtekningar på födda och döda i et land" [Remarks on the benefit of annual lists of births and deaths in a country].[113] In addition to the commission's members, Wargentin looked for advice and inspiration from interested Academy members, such as Anders Berch.[114]

At this time, there was also increasingly lively debate about whether all this material should be public. This was the perspective adopted by Wargentin in his articles. He was seconded by Berch and Faggot, who believed it was important to make the information accessible so that state officials could "make a proper choice for the public economy, with its associated tools and ordinances".[115] Additionally, the idea was that the Central Statistical Commission would publish some of its results in the *Transactions*, although this did not occur as regularly as intended. Instead, numerous other accounts of population changes in other parts of the country were published.[116]

A review of the articles containing population statistics that were published in the *Transactions* from 1740 to 1849 shows a peak in the 1770s, with another in the first two decades of the 19th century.[117] These peaks can be linked to a number of individuals; in the 1770s, Wargentin as well as measure inspector and Academy member Edvard Runeberg and, in the 19th century, Henrik Nicander, who was active as secretary of the Academy of Sciences.

THE MATERIAL ON POPULATION STATISTICS is an obvious example of how knowledge that circulated in the *Transactions* was subject to a thorough process of selection. Numbers that were found to be a risk to national security were never published, and were only disseminated within the Central Statistical Commission, the Secret Committee and the Council of the Realm. However, other figures of a less sensitive nature were printed in the *Transactions*.

Matters came to a head in 1765. The previous year, the Central Statistical Commission's population data from 1761 – both the total and for various areas of the country – had, despite everything, found its way into the *Transactions* because of a decision that some statistics could be published. At the 1765 Riksdag, which was the same year as updated analyses were presented to the Secret Committee for the third time, this was noted by a bishop, Filenius, who complained to the Secret Committee that national secrets were being spread to the public in this manner.[118] The following year, despite the bishop's misgivings, Wargentin was able to openly publish his perhaps most important results in the field of population statistics, namely a survey of age-specific mortality rates for the whole of Sweden, including rural areas.[119] The view of population statistics apparently began to shift in the mid-1760s, from a secret instrument for state governance to public scientific findings.

AFTER WARGENTIN'S DEATH IN 1783, the close links between the Academy of Sciences and the Central Statistical Commission appear to have become more distant. Fewer articles on population were published in the *Transactions* in the final two decades of the 18th century, partly due to the Academy's period of decline following the death of Wargentin, when statistics was one of the areas that waned. The theme returned in the early 19th century, thanks to Secretary Nicander who was also the director of the Central Statistical Commission. Activities became increasingly available to the public at this time. In 1802, Nicander had given his results greater circulation by reprinting selected articles in the *Transactions* when the published reports had run out. The 1809 Instrument of Government, which re-established the freedom of the press in Sweden, led to statistical information being circulated on a considerably larger scale.[120] At the same time, ties with the Academy of Sciences were definitively cut. The Central Statistical Commission continued its statistical activities until the mid-19th century, when it was renamed. Eventually, another change of name laid the foundation of the present-day Statistics Sweden.[121]

The Academy of Sciences was thus extremely active in inventorying plants, animals and other natural resources, as well as industrial activity around the country, and the size of the population, its age and other characteristics. Often, these inventory activities were combined, so that parish reports were as likely to include descriptions of soil types and handicrafts as quantitative data about the composition of the population and cattle stocks. However, one difference has been highlighted, as travel descriptions that primarily cover industry and natural resources rarely include extensive quantitative data while, conversely, population studies are completely engaged with figures and quantities.[122] It is conceivable that both these perspectives on national resources and conditions could be said to have merged in a third survey project with which the Academy of Sciences was involved, that of measuring latitude and longitude.

Measurement

Geodesy is the science of the Earth's shape and the determination of locations in relation to each other and to the landscape. This type of knowledge is invaluable in the production of topographic maps, which was one task that occupied the Academy of Sciences from the end of the 18th century. Topography was not actually of particular interest from a "utilist" perspective, in which the population, means of production and natural resources were vital to increased production. Instead, it was the military's more mobile warfare in the early 19th century that really encouraged an interest in topographic maps. In the 18th century, attempts had been limited to surveying the border with Norway and improving nautical charts, with the obvious exception of the French officer and Academy member Pierre de Maupertuis' famous degree measurements in Tornedalen in 1736–37, which aimed to determine the shape of the Earth. However, that was before the Academy in Sweden had been founded.

After the Academy of Sciences' observatory was established in 1753, it soon became a centre for the collection of astronomical determinants of location, both in Sweden and abroad. Even if the Land Survey Board began measuring latitude in the 1740s, the first major project was the survey of the Swedish-Norwegian border in 1738–1767, due to the availability of new and portable instruments for measuring angles. At the same time, latitude data for around a hundred places in Sweden was published by Faggot.[123]

TRIANGULATIONS WERE OTHERWISE EXPENSIVE and demanding – using two points at a known distance from each other to determine the distance to a third point – particularly in a forested and sparsely populated country such as Sweden. Measuring coastlines was easier, and of greater military interest. Coastline measurements were performed by the Admiralty Board from 1757 onward, leading to a new nautical atlas at the end of the 18th century. The navy continued to measure the coasts of Sweden and Finland in the early 19th century and their results were regularly published in the *Transactions*. Despite the aspects of military strategy, there were no qualms about disseminating this information, such as there had been for population statistics. Other geodetic projects, such as Baron and Mining Councillor Samuel Gustaf Hermelin's various private arrangements, also resulted in publication in the *Transactions*.

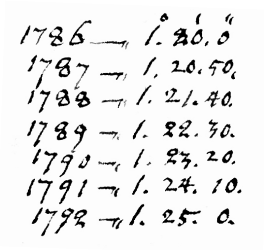
This marks a clear change in the technologies used for determining the longitude and latitude of various locations. In the mid-18th century, astronomical observations and data were primarily used. Of all these observations, many aimed at acquiring knowledge of the Earth rather than of the heavens. But methods changed, and towards the end of the century the use of various measuring instruments in terrain became more common. This also entailed changes to the role of the Academy of Sciences. While Wargentin and the Academy observatory had comprised an institution that actively gathered data and provided expertise for various projects, towards the end of the 18th century the Academy's task was, in the best case, to publish results. Land surveys had increasingly become a military activity.[124]

HOWEVER, THERE WERE EXCEPTIONS, such as Hermelin's mapping project which, from the end of the 18th century, was the most ambitious in Sweden. Hermelin was an entrepreneur with an extensive private fortune that he loved to spend on industrial projects, preferably in northern Sweden. At the time, this part of the country was the object of great interest among members of the Academy of Sciences, of whom Hermelin was one of the more influential. Accordingly, in the first decade of the 19th century, Hermelin and the Academy cooperated on projects relating to surveys of northern Sweden and Finland, a precursor to the Academy of Sciences' more regular support for natural history expeditions from the 1810s. At the same time, Hermelin also tried to establish a "Geographic Office", a central organisation for the collection of data and the development and publication of maps. However, a significant crisis in the foundry industry led to financial difficulty for Hermelin and plans had to be shelved.

The biggest survey in which the Academy of Sciences was involved was a new measurement project in Tornedalen in 1802–1803. There were several motivations for the expedition – science, propaganda and nationalism; this combination of reasons was necessary to obtain the necessary funding for a project of this size. Whether it was successful or not seems to have depended on who was asked. Some foreign observers regarded the whole thing as redundant, but the expedition participants themselves were effusive in their report to the Academy of Sciences. Rewards were not slow to arrive, in the form of salary increases and employment at the Academy.[125]

Heaven, Earth and the days

Astronomy was otherwise one of the main fields of the Academy of Sciences. It would have been strange otherwise, considering that two influential secretaries, Pehr Elvius and Pehr Wargentin, both had the observation of heavenly bodies as their primary interest. Together they succeeded, one after the other, in establishing an observatory north of Drottninggatan, on the highest point of Brunkebergsåsen, which accordingly came to be known as Observatoriekullen [Observatory Hill]. Naturally, all of this was built upon the almanac monopoly, which funded some of this activity. The Academy of Sciences' observatory, which was inaugurated with great fanfare in 1753, thus became its first building and was more or less dedicated to astronomy. In this context, it is important to note that astronomical observations required international cooperation, something to which scientific academies were more suited than the universities of the time. The Swedish Academy of Sciences was no exception and, here too, astronomy was soon at the forefront.



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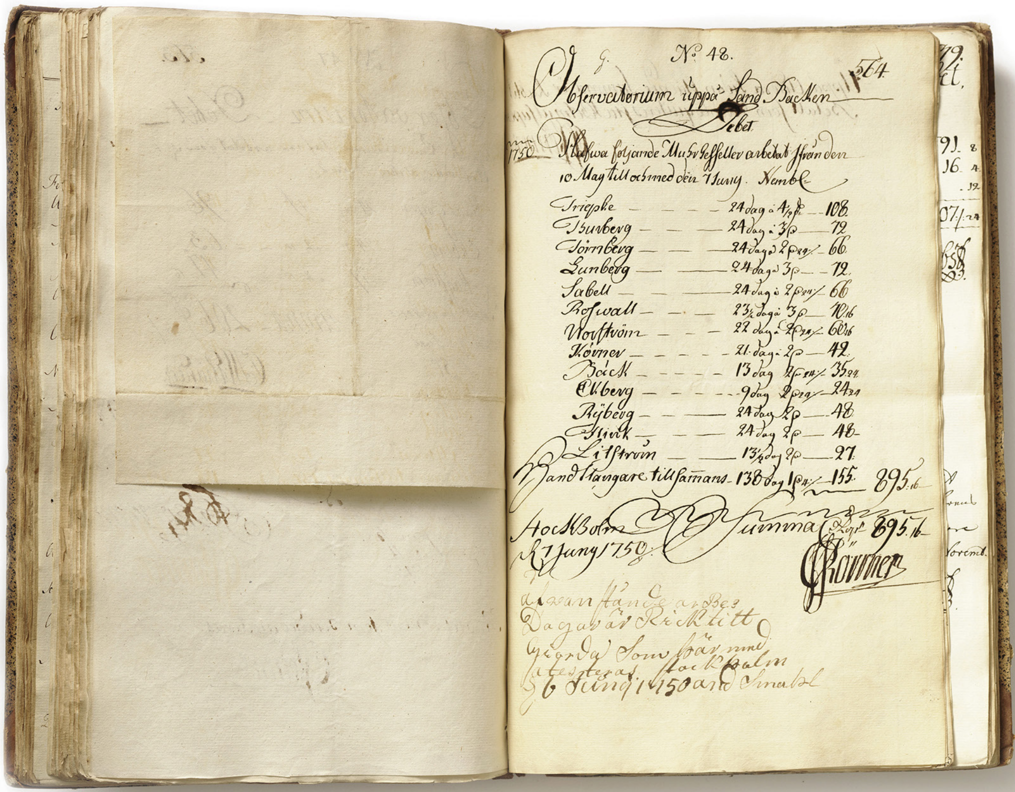
Astronomical cartography
p. 468–474

One example of cooperation was the measurement of the lunar parallax in 1751, a French initiative that entailed measuring the distance of the Moon from the Earth using observations from two points on the Earth at the greatest possible distance from each other. A French astronomer travelled to the Cape of Good Hope for this purpose, and European astronomers were encouraged to participate. The Swedish ambassador in Paris, Carl Fredrik Scheffer, involved Wargentin in this and, in turn, he mobilised all Swedish astronomers. Wargentin made observations in Stockholm using simple instruments, while others were involved in Åbo, Lund and as far north as Torneå. The results of these efforts were published in the *Transactions* in 1758, establishing that the distance between the Earth and the Moon varied between 62.964 and 56.502 Earth radii.[126]

They had also tried to establish the solar parallax, but these results were still too unreliable due to inadequate precision. Instead, European astronomers used a method that had been developed in the early 18th century and which was based on using the transit of Venus across the solar disc to more precisely determine the distance to the Sun. The problem was that these transits can only rarely be observed from the Earth; they occur in pairs, with eight years between the two occasions, and over a century between each pair. In the best case, an astronomer can hope to observe two transits of Venus in their lifetime. And, even then, the sky needs to be clear.

THE TRANSITS OF VENUS IN 1761 AND 1769 were international astronomical events, long anticipated and a cause of feverish activity, also at the Academy of Sciences' observatory. And not just there, as almost every eye trained in astronomy in Sweden was involved in this work. In Sweden and Finland, the transit of Venus was observed in around ten locations from the very early morning of 6 June 1761. The country was thus one of the most assiduous in Europe; only France superseded Sweden in the number of observations. Reports were read out at the Academy of Sciences and printed in the *Transactions*. Soon these accounts spread to astronomers throughout Europe. The Academy of Sciences was responsible for a large part of the international exchange, but all these observations were not the end of the story. Instead, the aim was soon set on 3 June 1769, when the next transit of Venus was expected. This time, the situation in Sweden was more complicated, because the entire transit could only be observed in the north of the country. Further

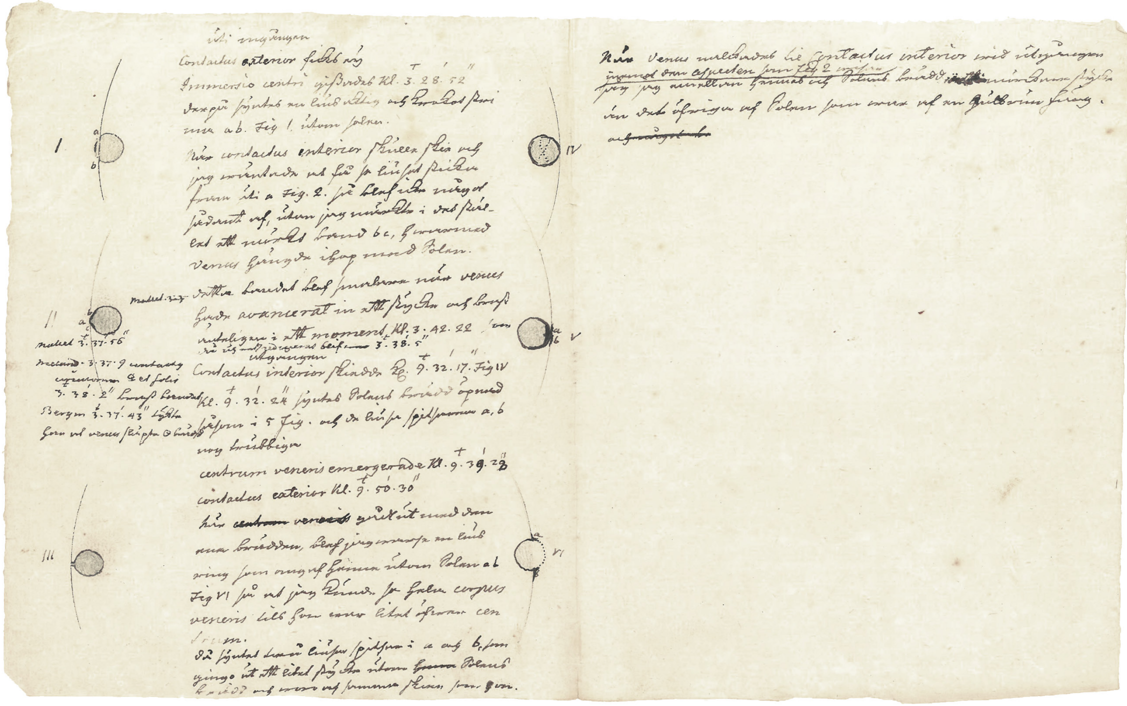


VERIFICATION OF WAGES paid to apprentice masons working on the construction of the Academy's observatory in 1750.

south, the Sun would set before the spectacle was complete. A great deal of planning and resources went into sending astronomers north, to the small villages of Pello and Torneå. The King in Council provided 9,000 daler in copper coin and also sent a Danish expedition to northern Scandinavia. However, despite all this money and effort, the observations were less than first-rate. Overcast weather caused problems, even if the clouds disappeared just as Venus entered the edge of the Sun and when it left the solar disc.

The conditions had not been ideal and the results were thus difficult to interpret. They were even the subject of a scientific dispute until the mid-1770s, with consequences that lasted for decades. Still, when the dust had settled, the figures were judged to be reasonable and the distance of the Sun was assessed as only a few per cent closer than that often stated today.[127]

ASTRONOMERS WERE ALSO THOSE who initiated continuous weather observations; the first ones in Sweden are from 1720 – before the Academy was founded. The Academy of Sciences soon received journals with weather



THE TRANSIT OF VENUS on 3 June 1769 was observed by Wargentin and reported in the *Transactions* later that year. The drawings show how Venus first moves onto the solar disc (ingress) and then outside (egress).

observations from interested people around the country, who used both barometers and thermometers in their efforts, instruments that were relatively new at that time. All of this weather data was interesting, particularly from the late 1740s, when the Academy became responsible for publishing almanacs, which also described upcoming weather. As stated in the previous chapter, a law against making predictions in almanacs had been enacted back in 1707, but there was an exception for weather predictions because they were so important to the demand for almanacs. The Academy therefore continued to publish weather predictions in almanacs until 1869, despite members' criticism of the practice before the privilege had been awarded. There was a basis for these weather predictions, namely the Antique idea that the weather is repeated every nineteenth year according to the metonic Moon cycle.[128] At the observatory, the secretary was also expected to observe and record the weather in Stockholm. This task was actually introduced in 1745 but, for various reasons – tardiness, waits for instruments, et cetera – Wargentin did not start doing so until the mid-1750s. The weather was then reported retrospectively in *Stockholms Wekoblad* [*Stockholm Weekly Journal*] from 1771 and in the Patriotic Society's *Hushållnings-Journal*.[129]

After 1800, meteorology had something of a boost in Sweden, with the Academy of Sciences as the primary organisation. This did not really involve any scientific breakthroughs, rather the collection of observations and readings from thermometers and barometers. Laypeople around the country were encouraged to record observations and their journals were received and collected as part of a system that could be called a field network; collection of knowledge in the field is dependent on linking together observations from geographically separated laypeople for analysis.[130] This description is an excellent fit for early meteorology.

Post- och Inrikes Tidningar, the official newspaper of Sweden, continued to publish excerpts from the previous month's weather observations. The inspiration for these geographically distributed observation activities came from Germany, where a meteorological society in Mannheim had contacted Wargentin in the 1780s, hoping to expand their network of observation posts to Sweden. The point of the Mannheim system was a standardised approach that used identical instruments – thermometers, compasses and barometers – and readings entered into printed forms.

In 1785, the Academy of Sciences proposed the creation of a weather observation system using the Mannheim model, in which mathematics teachers at colleges, the professors of physics in Åbo and Greifswald, and the pastors in Torneå and Kajaneborg would manage the instruments at their respective locations. At least officially, the purpose was to investigate whether the metonic Moon cycle really could be used to predict weather in the almanac. The proposal was approved by the King in Council, and in Mannheim there was joy at the Scandinavian successes.

For there were successes, even if some of the measurement series were a little short. In some cases, external help could rescue elements of the project. A housekeeper stepped in as an observer in Torneå and a widow took over the task in Brunflo. The very best was the teacher in Strängnäs who kept detailed diaries every year from 1786 to 1820, and was finally rewarded with the Wargentin medal in gold for his work. This was not undeserved, given that observations should be made three times per day, week after week, month after month, preferably without the person leaving their place of residence. For college teachers, this activity was regulated in the school ordinance of 1807. Initially, these tasks were to be performed with no compensation, but the Academy of Sciences soon began to encourage its information providers by sending a silver jetton for every submitted annual journal. There can be no doubt that the circulation of knowledge performed by the Academy of Sciences not only dealt with disseminating findings in journals and almanacs, but equally involved mobilising systems for the collection of data series from all the corners of the kingdom. As regards meteorological observations, the Academy of Sciences can somewhat impertinently be likened to a pump, ensuring that knowledge circulated in a meteorological network, along with standard instruments, completed forms and silver jettons.

However, the result of all that activity was not as impressive. Apart from a few articles in the *Transactions* in the 1790s and the first years of the 19th century, not a lot was produced by the project. The observation data appears to have simply been too extensive for any of those responsible, such as Henric Nicander, to be able to summon the effort, boldness and, in particular, the time necessary to tackle its analysis. When Nicander, in his 1814 Presiding Committee speech, finally denied the Moon's influence on the weather and the metonic Moon cycle's significance for weather predictions, he did not even mention the observations managed by the Academy of Sciences. As previously stated, the Academy unconcernedly continued publishing the weather in the almanac for several decades.[131]

The instrument collection

As we have seen, a great deal of the research activities at the Academy of Sciences in the 18th century involved surveys and observations. These could involve land and people, or planets and suns. Another important activity to support research was the collection of various items such as scientific instruments, natural history specimens and relevant research literature. Naturally, these props were invaluable to an organisation that was serious about its faith in experience-based knowledge and the value of empirical studies. The collections provided access to natural samples and materials, which could be used for both detailed studies and as concrete examples during lectures. Accordingly, from its very beginning in 1739, the Academy of Sciences received submissions in the form of different types of physical objects that should be preserved and cared for. The very first gift was "a Fungus", donated by one of the founders in August 1739.[132]

The potential creation of an instrument collection was discussed by the Academy of Sciences from the mid-18th century onward. The idea was that it would function as a basis for experiments in the new natural science, personified by names such as Robert Boyle at the Royal Society in London. As we saw in the previous chapter, Boyle was a natural source of inspiration, as was Francis Bacon, who, even posthumously, exerted great influence upon the same society. Of course, the instruments could be used in teaching and in public experiments that had an aura of entertainment.[133]

Nowadays, it is difficult to imagine the symbolism that was associated with a model collection, particularly if it was of the more extensive and well-constructed kind. After the breakthrough of Cartesian-Newtonian mechanics, scientific instruments represented a new conception of the world, one that meant that different phenomena, from the movement of planets to that of waterwheels, could be calculated and predicted. On this foundation, scientific instruments in the 18th century can be regarded as physical manifestations of new scientific theories about the world. They symbolised theoretical knowledge of a regularly ordered universe. In an equivalent manner, the models have been linked to a more empirically focused and Baconian natural philosophy, one that was increasingly reflected in ideas about how technical instruction should be conducted – on the basis of actual work and experience, rather than book learning and rote principles.[134] A model collection allowed an entirely new organisation for conveying scientific and technical knowledge worth the name in the mid-18th century. Accordingly, it also had clear political implications.

SINCE THE 17TH AND 18TH CENTURIES, many attempts had been made to organise some form of continual technical instruction in Sweden, almost always with models as aids. Olof Rudbeck had created a school of mechanics at Uppsala University, although the model collection went up in smoke in a fire in 1702.[135] Interest in scientific lectures continued to grow; it was a wide field, stretching from public autopsies in anatomical theatres to physics and chemistry experiments performed using specific instruments.

Public interest in popular lectures in physics and Newtonian mechanics had been utilised by Academy founder Mårten Triewald, at Riddarhuset in Stockholm. Anders Gabriel Duhre's *Laboratorium mathematico-oeconomicum* outside Uppsala was also part of this context in the 1720s.[136] Other educational efforts using models were made in various branches of the military, such as artillery and fortification, as well as in land surveys. In 1700, on the suggestion of Christopher Polhem, a scientist, inventor and industrialist, the Board of Mines had created a *Laboratorium mechanicum* for teaching purposes. However, it did not gain the importance that was originally intended, largely because Polhem prioritised other things.[137] After his death in 1751, there were still a number of models and instruments in the care of the Board of Mines, as well as at the Board of Trade, *Jernkontoret* [the Iron Office], the Fortifications Agency and the Board of Warfare. There was no general and continual technical instruction in Sweden, which was regarded as a problem at a time when economic policy was characterised by mercantilist ideals; these stated that imports should be avoided and exports promoted, not least by the domestic processing of raw materials using technical means.

Producing scientific instruments of various kinds was a new occupation, one that did not easily fit into the existing guild system that controlled manufacturing. In this situation, the Academy of Sciences came to function as a control body for the quality of the instruments that were produced. Interest in experimental sciences, such as physics and chemistry, as well as for subjects in which instruments were decisive in being able to conduct advanced research, such as astronomy, meant that the Academy of Sciences also promoted skilled instrument makers. The best known of these was Daniel Ekström, who had worked at the *Laboratorium mathematico-oeconomicum* and then travelled to England on an 18-month study visit, with a stop in Paris on the way home. After being elected as an Academy member in 1741, he received commissions for instruments from the Academy in the 1740s. In the early 1750s he not only had an instrument workshop at the Academy's observatory, but also received annual compensation for his work of 6,000 daler in copper coin. Although Ekström died just a few years after establishing his activities, their effects continued thanks to all the instrument makers he had trained.[138]

ESSAY
An unsuccessful mount
p. 475–481

A great deal of instrument making in Sweden was financed by the Manufactory Office, which also worked towards building up national production through generous loans and subsidies, particularly for textiles. This arrangement worked well, as long as the leading instrument makers received commissions from the Academy and were themselves members. Electricity machines and compasses were built, microscopes and air pumps that were sold to wealthy individuals or were used for teaching. They may have been included in the Academy's instrument collection and utilised at the Thamic lectures in mathematics and natural science. If there was a need for a more advanced microscope or other instrument, it was purchased from abroad.[139] One important addition was parts of the Adolf Fredrik instrument collection, donated to the Academy of Sciences by King Gustav III in 1772.[140]

However, towards the end of the 18th century, it appears that the organisation and care of these instruments, and the acquisition of new equipment, was in decline. Over time, it took longer and longer to add to the Academy's instrument collection.[141] The instrument makers were no longer members of the Academy and the social distance between the people who made the instruments and their potential users grew. By the end of the 18th century, instrument makers generally had to rely on a market that appears to have been too small to satisfy everyone.[142] The position of a specially appointed Thamic lecturer, who also managed the growing collecting of apparatus for the Academy of Sciences, remained throughout the 19th century and into the 20th century, and is described in more detail in the following chapter.

HOWEVER, IN THE MID-18TH CENTURY, this had not yet happened, when *capitaine mechanicus* Carl Knutberg proposed, in his admission speech to the Royal Academy of Sciences in 1754, that the *Laboratorium mechanicum* should be reinstated with the help of the Board of Mines' model collection, but under the auspices of the Academy of Sciences. Knutberg had been to Paris a few decades previously and probably noted that the French Academy of Sciences had stronger ties with the state, partly through its model collection. This proposal had added force because, from 1746, the Academy had had access to the Thamic funds, a donation to Riddarhuset of 30,000 daler in copper coin from a trade councillor in Gothenburg, Sebastian Tham. As mentioned in the previous chapter, Tham's intention had been to establish a series of lectures in the new natural philosophy. Knutberg's 1754 proposal was to use this donation to make the Swedish Academy of Sciences more relevant to the capital's political and administrative life by bringing together an impressive model collection, while also ensuring it was used for instructional purposes.[143]

This was not quite what happened. Still, in 1756, the King in Council decided – after a proposal by the Secret Committee – that a chamber of models was to be created from Polhem's estate, but with the Board of Mines as its principal, rather than the Academy of Sciences.[144] However, as we will see in the next chapter, the model collection would again cross paths with the Academy, almost seventy years later.

At the end of the 1750s, regular lectures were reintroduced for mathematics and natural science at the Academy of Sciences, when Johan Carl Wilcke – the man with the pressure cooker – was appointed as Thamic lecturer in experimental physics in 1759.[145] Initially, afternoon lectures were held on Mondays, Thursday and Saturdays, October to November and February to April. After a few years, Wilcke settled on twice-weekly lectures, but despite this, these free events became a fixture of the city's cultural life. Wilcke was promoted in 1770 to professor of physics, and became the secretary of the Academy of Sciences in 1784. Meanwhile, the lectures appear to have lost a little of their shine, which he mainly attributed to the lack of a good instrument collection, which meant that he had to describe other people's experiments rather than pull in the crowds with entertaining effects.[146] Still, he had begun to create a collection called the physics cabinet. Whether it was the volume of work entailed by the position of secretary or the lack of public interest that caused the Thamic lectures, once again, to be paused until 1797, will be left unsaid. This was when a new Thamic lecturer, Carl Gustaf Sjöstén, was appointed. He not only held regular lectures but also taught at the "mechanical school" run by the Academy of Fine Arts.[147]

THE FOUNDATION OF THIS MECHANICAL SCHOOL was the chamber of models created from Polhem's instrument collection, which the Board of

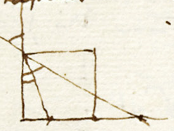
THE THAMIC DONATION was long a cornerstone of the Academy's economy, financing the position of secretary, among other things. However, following a decision in 1746, the Academy had to provide lectures for young nobles in return, known as the Thamic lectures. Overleaf: Pages from Johan Carl Wilcke's lecture notes.

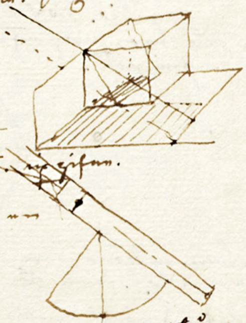
14:de Föreläsningen. d. 14. April 1763

Dictum. fer. qu: regul: radii p corpora pellur. transeat atq refringat.

Ním: ita ut sin: incid: d sin: refract: sint in constanti ratione.

Experim. Kepleri inter alia. quaz haec.



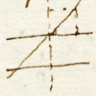


Många andra sätt är gifne.

ex. Newton med prisma- en annan gång.

detta är nu sielfva grunet och naturens förhållande. förgät åter nu är orsaken till efterrinnandet, så hafva mål flera därom brunderat sig, ibland hvilka Newton[s] tankar äro med naturen bäst öfverensstämmand

1) Newton. ex attractione. inde mutata velocitate. accelerata. in medio densiori.



Qd ex resolut: virium. facile adparet.

2) Dem före Carthesii. han concederade lius[et] lättare gång uti solidioribus.

uti in Marmore fac: globi volut. ac in panno.

Qd minus cum motum instantaneum tribuit Lumini. hic aliter sentiat.

ex bombarda explosa globi. sursum deflectit. aliter luce.

Qd ex resol: virium deducit.

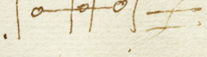
Ex utraq colligit, Lucem celerius moveri in solidioribus. densioribus. et rationem Velocit: inverse fuit densitates

Carthesii explicatioen är emot naturen. Qd pater alia probat: et Leibritzius. per parallelismum. radii incidentis et orientis

Ex Newt sent: sinus angul: incid et refract. sunt inverse ut Celeritates y medii

Ex Carthesii. Sentent. Celerit: y medii sunt ut densitates Qd, adeoq sinus angulorum I. d R. inverse ut celeritates

Qd. natura contrarium. p experim. iden. ex exemplo a manu d groba.



Fermatius. putavit. Celerit: seq: [illegible] moveri celerius in rariori q. primo verisimile erat.

unde deduxit. Ratio sinuum eadem directa Celeritatum

hoc ne: v Contr. superioris quod [illegible] locum ē invenit. nec natura consent

Alia quaestio. Quodnam Optim[um] sibi natura elegerit. vel minim[um]

1) via s. ē minima.

2) nec spatium. 3) nec temp.

sed. Actiom. quae componit. ex massa celer: d spatio.

p Maupertuis primum demonstr[atum] [illegible]

utom[illegible] flera. reph. refractionis.

Barrow. Descales.

Leibnitz. ~~Fermat~~. qui Carthesi[um]

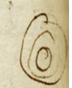
Euler Bernoulli. Clairaut. [illegible] halla med Newton.

Refr. in Aere.

prob. imediate experim. p [illegible]

Qd. in Anglia.

d in Gallia – – [illegible]



aden qu atmosphaera.

unde Curva solaris.

Omnia elevantur.

unde paradoxa. | O imago. oblo[nga]

Sol d luna obumbrata simul in Coelis

altit. stellarum mutant.

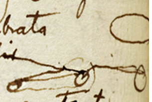
refr. dolini. antiquis. incognita.

alhasen. d Vitellio [illegible] refractio unica in [illegible]

Tycho primus.

intill till 45°.

Cassini [illegible] refr. qu [illegible] d crescere ab. aequat. ad polos ⅓ minuten [illegible] [illegible]



G ☉ inom 6 månader borta [illegible] utan sin. och spel: experien[tia]

...Föreläsningen. d. 18 Aprill. 1763.

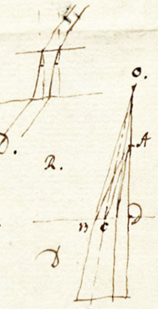
...mycket Observationer noggrant
... Refract: Aeris, hvilken vis
... Astron.
... för objecta Terrestria ... afslå-
... luftens beskaffenhet.
... morgon afton. Winter
... Middag. Sommar.
... terrestris bör noga med Måt-
... Nivellningar ifrågakomma. om
... längre öfver 1000 fot.
... Hauksbee. bevist detta med
...

... aldrig ofärmärkt igenom
... en del reflecteras af ytan.
... en del af ... Medii ...
... synes i sin måg i Camera

... först Mandel. Glas. L. Lufft ...
... Essay d'optique
... sur la lumiere 4to ...
... probat per Vacuo Colorum
... ...

... ad Superficies et corpora
... et Sphaerices.

... per Superf: parall.
Aut. §111.



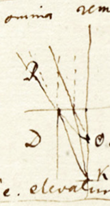
... parallele excunt

... Strålar.

... in ... D.
... formant ...
... O.
... ... D : ... R.
... Sing.
... 4 : 3.

... Strålarne ex D som strålen
... conveniunt in A.

... D. syg det ... A in D.
... ex alto. unde omnia ...



... radians in R.
... ex D in R.
... formant punctum
... O.
... R. videt K in O. ie. elevatum.
... ...

... Convergenter ad O
... concurrunt in K.

... visio ...

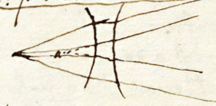
3. Prismate. 2. refract: vid Aut. §112.

16de 17de Föreläsn: på följande blad.

18de Föreläsningen. d. 28. Aprill 1763.

Widare Expl. af Autoris satser p. 122.

3.) Obj: per Vitra Concavo Concava minora appar:

a.) 

fri imaginaria proprie ...

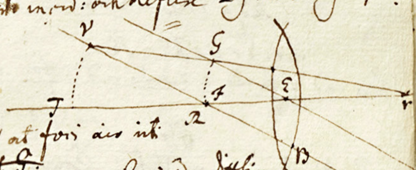
b.) 

5.) ∥le radier . skridar och ... en foc: imag.

6.) Att finna Foc för desse Glas. ... ∥le Strålar

först bevist huru foc för en yta
allena finnes.

Den är på Axis.
så at Dist. foci från ytan
till Rad. sphaerae. som
= Sin: incident : Differentia
Sin. incid: och Reflexe = Sinc. — Srefr.



bevist at foci äro uti
V. och G.

VB : RB = Sin incid : diffsin.

Om V r dragnes. blir G. foc. till andra
refraction.

Om ∥ Strålarne blifva ∥ till axis och R.
skinda puncta V. G. med Cirkelbågar
ned till T. F. ut. hvars Centra är
R. Σ.

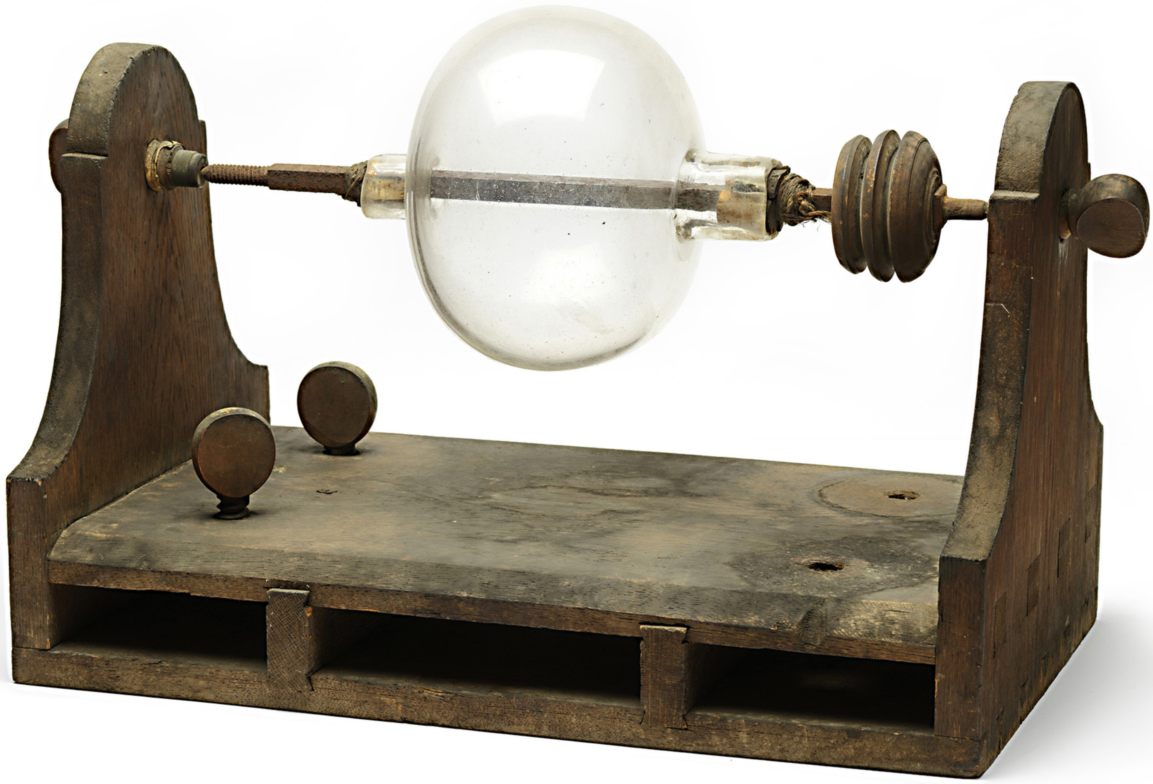
VB – RB : RB = Si – ... R. : Diff

VR : RB = Srefr: Diff Si och Sref.

RB constans. ergo VR constans. ob. ratio Sin.
constantem.

in Δ VRr. ΣGr.

ΣG : VR = rΣ : rR.



A MACHINE FOR GENERATING STATIC ELECTRICITY, which Wilcke probably demonstrated at his lectures.

Mines had received through royal decree in 1756. In the second half of the 18th century, a large number of models from *Jernkontoret*, the Royal Palace, the Board of Warfare and the Fortifications Agency were amassed in what is now the Wrangel Palace on the island of Riddarholmen, so that the Royal Chamber of Models, as the collection was known, grew to exceed 200 items. By 1801, it contained 350 different instruments and models.[148] At this time, the collection on public display was well-known and was one of Sweden's main attractions for visitors from near and far.

The collection was continually worn down and renewed and, at the end of the 18th century, it was, despite some signs of decline, the basis for instruction in the field of mechanics. It was for this purpose that the mechanical school was founded in 1798, as part of the Royal Academy of Fine Arts, and it was here that the Academy of Sciences' Thamic lecturer worked at the end of the 1790s.

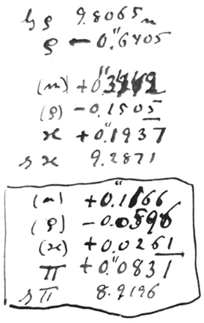
After a number of incidents, including an evacuation due to a fire on Riddarholmen in 1802 and an outing to Marieberg on the island of Kungsholmen in Stockholm, instruction activities and the model collection were moved to new premises in central Stockholm in 1805.[149] The following year, there was "complete inactivity", at least if we are to believe the managers of the school.[150] Not much appears to have remained of the formerly so attractive model collection, and only a few pupils participated in the languishing teaching. In the long run, the Academy of Fine Arts did not appear to have been the best principal for technical instruction either, and in 1813 the newly founded Academy of Agriculture took over these activities and the collection, which formed its mechanical department.

Meanwhile, the physics cabinet at the Academy of Sciences had hardly developed at all. In the late 18th century, additions to the apparatus collection were made through purchases, and in the mid-1790s it had more than 400 instruments and models. It was primarily expanded in the 1820s, and once again in the 1850s, using the same method. In the 19th century, the collections were also supplemented with various kinds of standard measures for use in standardisation.[151] However, in the early 19th century, lecture activity at the Academy of Sciences appears to have declined. The Thamic lecturer who succeeded Wilcke had started strongly, but then been unable to maintain steam. On one occasion he had even pawned a clock that was part of the instrument collection. Understandably, an investigation was called for, but the Academy management instead put new forces in place to focus activities on technology, after a proposal from A. N. Edelcrantz.[152] The fate and adventures of the instrument collection thus take new turns, ones better suited to the next chapter.

Shifting interests

Lecture activities at the Academy of Sciences being put on hold in the early 19th century was not unique. In the history of the Academy of Sciences, the end of the 18th and the early 19th centuries are described as a period of decline, for which different reasons have been proposed. Some people wish to highlight the importance of the permanent secretaries, and it is an incontrovertible fact that the death of Pehr Wargentin in December 1783 took its toll. Wargentin had successfully run the Academy of Sciences for almost thirty-five years, with extraordinary commitment. In parallel with his own research, he maintained a large network of contacts inside and outside Sweden and, with almost no help, managed all the activities of the Academy. One indication of Wargentin's significance is that he was replaced by not just one, but two secretaries.

Those who came after him were Johan Carl Wilcke, Henric Nicander, Daniel Melanderhjelm, Jöns Svanberg, Carl Gustaf Sjöstén and Olof Swartz. This was a mixed group of somewhat competent officials, of whom Sjöstén



ESSAY
Calculation work
p. 482–486

ESSAY
Calculating machines
p. 487–490

appears to have been the most criticised for what one of his successors, Jacob Berzelius, called "neglect and disorganisation".[153] Nor do the secretaries' stately names reveal that all of them, except the last one, represented the exact sciences. After Wilcke's death in 1796, it had been difficult to find a new unifying force and, after some meandering, the position again went to an astronomer, Daniel Melanderhjelm, who, for the sake of the position, demanded two deputies, Jöns Svanberg and Carl Gustaf Sjöstén, both mathematicians and physicists. A biologist, Swartz, had his thoughts about the strong dominance of what he called "the a+b men" in the Academy management which, in his opinion, was dominated by researchers from disciplines characterised by calculations, such as mathematics, physics or astronomy. This influence was first broken in 1811, when Swartz himself took over the position of secretary.[154] Berzelius, who succeeded Swartz as permanent secretary in 1818, is the person said to have ended the decline of the Academy of Sciences.[155]

Others maintain that it was not only a number of less energetic successors to Wargentin that meant that the golden age of the Academy of Sciences ended at the same time as the Age of Liberty in 1772 and with the close of the 18th century. More generally, it has been stated that the mid-18th century was a glorious period for Swedish natural science as a whole, with numerous names that were renowned across Europe. When these people died, there were few or no others who were equally famous and were able to take over. However, there was also a more overarching tendency that meant that studies of nature were not valued as highly towards the end of the 18th century as they once were. This also applied to the universities, where career opportunities had become increasingly hopeless.[156] The field of knowledge lost its ideological position as "utilism" and mercantilism fell out of fashion. The natural scientist had become a comic or pitiable figure, in a time that preferred the fine arts to technology.[157]

The declining interest in natural philosophy around 1800 was also noticeable in the areas of knowledge that occupied the new academies formed during this period. Several of these have already been named above, such as the Patriotic Society in 1766, the Swedish Academy in 1786, the Royal Academy of War Sciences in 1796 and the Royal Academy of Agriculture in 1811.[158] In addition to these, there is the Royal Academy of Letters, History and Antiques, which was actually founded in 1753, but was reorganised in 1786. It is apparent that the Academy of Sciences' competition increased at this time.

THE CHANGED CIRCUMSTANCES OF THE ACADEMY OF SCIENCES can be captured in a comparison between the two most publicised happenings of the 18th century. Both took place upon Observatoriekullen in the presence of the king, in front of the Academy of Sciences' observatory and in September. But there the similarities end. The first occasion was the inauguration of the new observatory on 20 September 1753. The second occasion was a balloon launch on 17 September 1784. The former had been planned for a long time, an opening ceremony to celebrate the completion of the observatory of the Academy of Sciences, a temple to science, ready to house astronomers and their instruments. Naturally, a commemorative coin was engraved for the event (which, just as naturally, was not ready until the autumn of 1754). And, of course, the president of the Academy, Anders Johan von Höpken, held an inauguration speech about the history of science as a battle between light and darkness. It was a magnificent event, with 33 members and numerous other honorary guests and shining political stars who received His Majesty Adolf Fredrik in the observatory courtyard. But this event was primarily dedicated to the result of the Academy of Sciences' own striving to conduct research at a high international level.[159]

The latter happening was different. Observatoriekullen was packed with people and, at the head of the crowd, was Gustav III with his court and other dignitaries. The subject of interest was the launch of a hydrogen balloon, or an "aerostatic ball" as it was called, something that had been tested with great interest in Paris just over a year before. This time, the initiative had not come from the Academy, but from the royal court, and was facilitated through public fundraising. The construction was built by a Lieutenant Silfverhielm, with ready help from experimental physicists such as Johan Carl Wilcke and the Uppsala chemist Torbern Bergman. The launch of the aerostatic ball was undeniably a spectacle. Spectators were held back by the Svea Life Guards, as the balloon was filled with gas and a live cat placed in the basket beneath it. A signal rocket was fired and the queen cut a ribbon. The balloon then rose above the rooftops with the cat and basket, as well as a note asking whoever found the balloon to return it to the office of the Academy of Sciences. The balloon was found on Värmdö, in the Stockholm archipelago, three weeks later. In the history of the Academy of Sciences, it has been solemnly stated that: "Our first Swedish balloon launch had no practical consequences."[160]

Thirty years of political and scientific change separate these two events, and created new circumstances for the Academy of Sciences. Swedish political life was no longer dominated by two political parties, the Hats and the Caps, but was governed by an authoritarian king who decided when the Riksdag should assemble. Swedish research and Swedish researchers no longer enjoyed the same attention in Europe as they had in the 1750s. The inauguration of the observatory was a symbolic event, staged for a small group of selected members and other members of the societal elite. It had been planned by the Academy of Sciences to thank those who contributed to establishing the observatory, and to celebrate the observatory building's promise of a better understanding for the movements of the planets, the passage of the days and the Earth's geography. In comparison, the balloon launch was not weighed down by symbols, but was instead organised to respond to curiosity about new technology. It was not empty of promise – there was of course excitement in the idea that, in the future, people could fly through the air like a cat in a basket. But the promises were for the effects of knowledge, not just the availability of knowledge itself, as the observatory had promised at its inauguration.

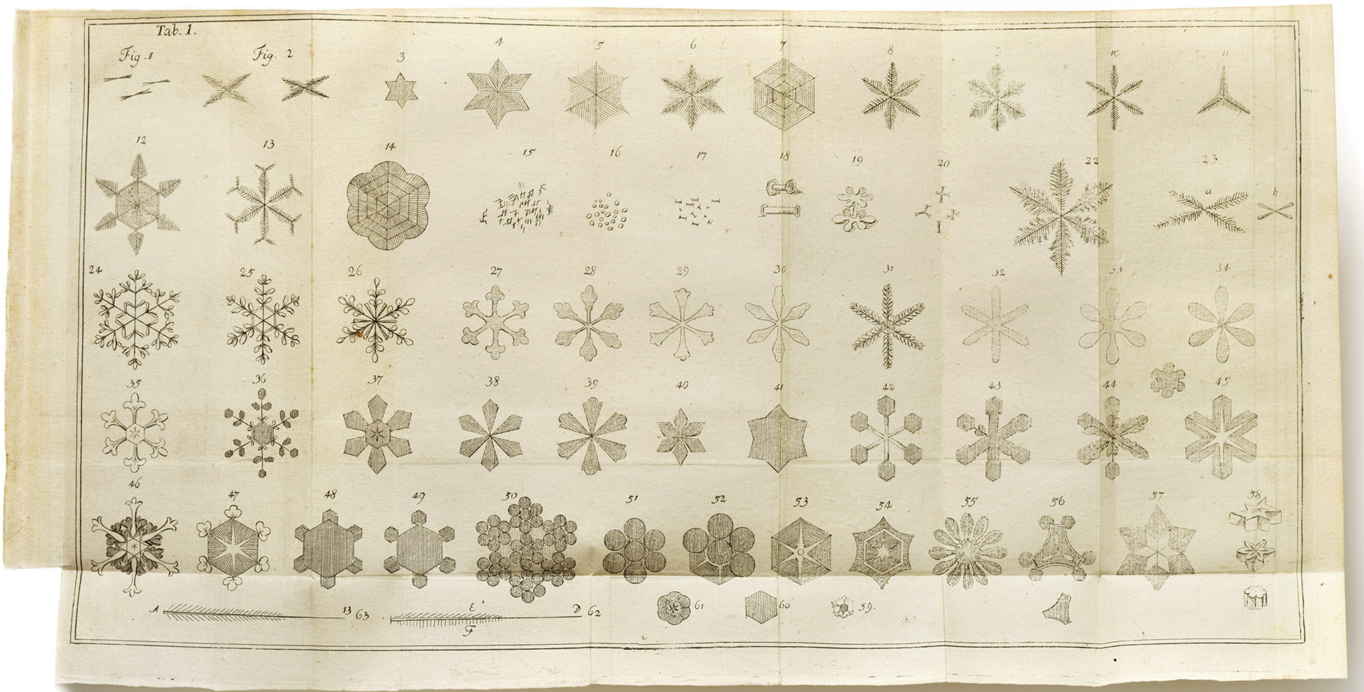
These two events reflect opposing views of knowledge. On the one side was the perspective that knowledge was the concern of the elite, focusing on how new findings could be achieved. On the other side was a view of knowledge that involved broader interests and was more aimed at the consequences of knowledge. The Academy of Sciences has always encompassed both approaches, but at the end of the 18th century the former, more elitist, attitude bowed to a more outwardly focused perspective. Calling this a period of decline in the history of the Academy of Sciences probably leads us down the wrong path. Instead, the contrasts between the Academy of Sciences' activity in the mid-18th century and the end of the century should be understood as a result of shifting perspectives regarding the purpose of knowledge and its targets.

New organisation at the Academy

The same tensions between the view of knowledge as a concern of the elite or something relevant to society as a whole can be said to have affected the Royal Society in London. At the start of the 19th century, critics felt that it likened a club for respectable educated gentlemen who lacked up-to-date scientific insight. The Paris academy was different, in that after the French Revolution it was primarily represented by natural scientists who were also influential outside France.[161] Conditions at the Swedish Academy of Sciences were probably closer to the English than the French academy.

These tensions surfaced in 1813, when new foreign members were to be elected. When it became apparent that the pastor of Stockholm's French reform church, Catteau-Calleville, had received more votes than the famous British astronomer William Herschel, one of the younger members reacted indignantly, asking "Is this an academy of science?". The answer was that scientific contributions were not all that mattered to elections.

The person who objected was no less than the already world-renowned Swedish chemist Jacob Berzelius, who had had a rocket-like trajectory in his academic career as a professor of medicine and pharmacology at the Caroline Medico-Chirurgical Institute in Stockholm. He had been elected to the Academy in 1808, at just 29 years old, and had even had time to lose an



COPPERPLATE OF "THE DIVERGENCY OF SNOW-FIGURES"
published in 1761 in a paper by Johan Carl Wilcke.

election for the post of secretary in 1811. Still, there was no doubting Berzelius' skill as a chemist or his ability to adopt new ideas, especially the new atomic theory in chemistry.

Berzelius in no way dominated the Academy in the 1810s. Instead, he has been characterised as the "angry young man, who made sarcastic comments and was plagued by this respectable bureaucratic toothlessness".[162] His frustration was not least due to the declining scholarly competence within the Academy. Excluding Berzelius, there were few international stars when compared to its former state.[163] The Swedish Academy of Sciences, which had once been one of Europe's foremost, had, according to one member, now been reduced to an assembly that did nothing other "than pay its officials".[164] This decline was also registered by foreign visitors.

In the early 19th century, it also became more apparent that speeches by the Presiding Committee and eulogies at the Academy of Sciences no longer had the prominent role they once had. Admission speeches by new members had never become established as a strong tradition, but ceased entirely at the start of the 1790s. Eloquence still attracted a learned audience, but had found a stronghold in the Swedish Academy. Even if Presiding Committee speeches were held until the mid-19th century, they were not published as frequently, with around half being printed after 1800. Eulogies had been neglected since the 1790s, when they could be held several years after the deceased had been interred. They did have a brief renaissance at the start of the 19th century, but their importance once again came into question. They were held less frequently in the first decades of the 19th century, and the final eulogy for a deceased member was held in 1837. Instead, obituaries in the *Transactions* took precedence as a means of honouring the memory of a member.

THE NEW ORGANISATION IS ONE SIGN of a slow glide for the heart of decision-making at the Academy of Sciences. Meetings and negotiations in plenum, which all members can attend, slowly became of lesser significance and activities were increasingly governed by the Academy's management – the Inspectura ærarii – and the secretary.[165] This tendency would become even more marked after 1818, when Berzelius assumed the post of secretary.

When Berzelius was named secretary of the Academy of Sciences in November 1818, a committee was appointed to review the Academy's activities in their entirety, its organisation and finances. The poor state of the natural sciences in general, and the Academy of Sciences in particular, was an incentive for change, and this committee can be seen as a clear indication that that Academy was now facing a potentially formative sequence of events. Berzelius had been spending time in Paris and did not return to Stockholm until September 1819, so did not participate in this painstaking work. He received a proposal for new statutes by post to Paris in December 1818, but took no action. Instead, the continued reformation of the Academy of Sciences was delayed until February 1820, when Berzelius initiated a committee to develop new statutes. Work now proceeded at a rapid pace, because it could be based upon what had been previously achieved. A proposal was sent to the King in Council in June and the new statutes were promulgated in November 1820. Special committees were now to be the starting point of the Academy's activities, while new forms of election and new class divisions entailed a stronger basis for the recruitment of members with scientific expertise. Although it would take many decades before these changes had any effect on the members, the new statutes were a great success for Berzelius; he regarded them as a foundation on which to transform the organisation into an Academy of Sciences in the true, modern meaning of the words.[166]

Conclusions

During the Age of Liberty, the Academy of Sciences was undoubtedly successful in its battle to promote the search for knowledge and new findings, ones that were in some way beneficial. It supported knowledge practitioners in accordance with the ideological waves characterised by patriotism, "utilism", mercantilism and physico-theology. In addition, there was a search for knowledge that – in the best case – would be distinguished by its rationalism and empiricism, even if this work suffered misfortunes. Efforts were often associated with a newer, more mechanistic view of the world. The formative events that were occurring when the Academy was founded in 1739 – the Hats' rise to power and the state of knowledge policy in the following decades – gave the organisation some path dependence throughout the 18th century and the first decades of the 19th century. At this time, much remained the way it had been established in the first few years after its founding; activities were simply scaled up, with more employees, larger premises and more extensive collections.

Primarily, the Academy was similar to some foreign academies in that it assembled esteemed members, and regularly published almanacs and scholarly journals that had a broader circulation than their own sphere. It also had a library, it organised lectures and coordinated Swedish contributions to national and international research projects and expeditions. Of course, whether the Academy succeeded in becoming as beneficial a knowledge organisation as has been hoped for is open to discussion, but is hardly of particular interest. Instead, what is of interest is that the Academy of Sciences cleverly succeeded in initiating circulation in numerous areas of knowledge, in a variety of different contexts and in a number of different ways.

This successful strategy was largely based upon thorough inventories and survey work in differing fields, from soil fertility to population composition. It is an indisputable fact that the Academy of Sciences, more or less successfully, involved different stakeholders in its work as often as it could, from entrepreneurs and politicians in the capital and the learned people of the dioceses, to pastors and officers in rural areas. This applied to everything from the introduction of new crops to help with regular weather observations. In other words, the Academy of Sciences was in no way an organisation that only attempted to disseminate information from a capital-based elite to a simple peasantry through almanacs and the *Transactions of the Academy of Sciences*. Instead, its mission was to collect beneficial information from all those who could provide it, to have a trusted group of esteemed members evaluate and process it in their capacity as citizens and patriots, and then, if it was deemed promising, to announce its conclusions as findings and insights to a mixed audience, which could equally well comprise the literate general public as it could university professors. By these means, the Academy of Sciences promoted both the domestic and international circulation of knowledge.