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## **Teaching Botany Inspired by Linnaeus – Is it possible?**

**C**arl Linnaeus (1707-1778) has become one of the world's most renowned scientists because of his important contributions to science. Naturally, most research has focused on Linnaeus' scientific work while his qualities as a teacher have been given relatively little attention. However, investigating his role as a teacher is important, since there is an interesting connection between academic research and teaching skills. A scientist who is a good teacher may inspire many students to become scientists as well. A scientist and teacher who does not only influence the students, but also allows herself or himself to be influenced by them may enhance the creative energy in her or his research.

To investigate Linnaeus' role as a teacher and a possible connection between his science and teaching, a cross-disciplinary research project was initiated in Sweden in 2002: "To teach and learn in the service of science - a study of Linnaeus and his students". The project was financed by The Committee of Educational Research at the Swedish Research Council and consisted of the project leader Dr Åsa Karlsson (history), Dr Nils Ekedahl (rhetoric), Dr Hanna Hodacs (history), Dr Mariette Manktelow (systematic botany), Dr Kenneth Nyberg (history) and Dr Annika Ström (Latin).

To draw conclusions about a historical person's teaching abili-

ties is a difficult task. Teaching is usually not written, but oral, leaving fewer historical sources. Teaching performance is not easy to evaluate and its effects are difficult to measure. In the case of Linnaeus we were provided with an unusually high number of historical sources and the cross-disciplinary approach proved fruitful both regarding our research and our conclusions. This essay is a short summary of our main results and some further conclusions.

### Carl Linnaeus - a good teacher?

Being a “good teacher” is a concept often used and much desired in all teaching situations. But what does this concept mean? At many universities undergraduate and graduate students take compulsory courses in basic teaching skills. During such courses, the lecturing situation is analysed and the participants may, for example, practice their teaching while being filmed and then criticised in the group. In such a course “a good teacher” may be characterized as being knowledgeable, stimulating, enthusiastic, activating, structured, clear in speech and writing, explanatory, pedagogic, communicative, open to criticism, conscious, secure, awe-inspiring, humorous, nice and having good confidence.<sup>1</sup> Although these characteristics of a presumably good teacher are a measurement in modern times with modern time criteria, we may keep them in mind when analyzing a historical person, presuming that the ability to inspire others is a relatively timeless phenomenon.

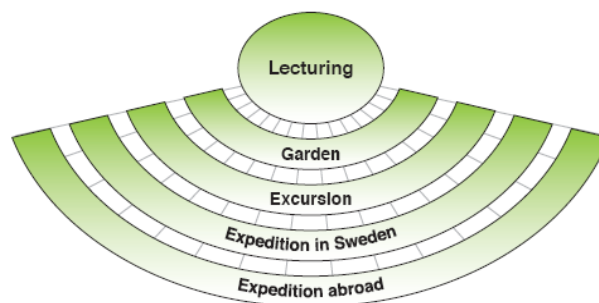
Is it possible to judge if a person who lived 250 years ago was a good teacher? The truth is of course that we cannot judge, but we may hypothesize. We are confined to a certain number of historical sources to build our hypothesis. Linnaeus expressed in writing his

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<sup>1</sup> These qualities of a good teacher are taken from a recent basic teaching course at Uppsala University, Sweden.

own views on teaching. There are a number of contemporary student witness reports. Some students who followed Linnaeus' teachings wrote down their perception of Linnaeus as a teacher in travel reports or memoirs. There are a number of students' protocols preserved, scattered in different libraries in Sweden. The protocols written on excursions are interesting since they were written by a secretary selected by Linnaeus and later copied by the other students. One may therefore presume that those protocols are accurate notes. Linnaeus' teaching abilities would also be reflected in the attraction of students to his lectures, the spreading of lecture-based knowledge, and the students' own careers.

**Linnaeus' tutoring model**



*Fig. 1. Carl Linnaeus' model of teaching and tutoring may be illustrated by concentric rings of teaching situations, through which he lead the students from a passive lecturing situation gradually into scientific independence. [Illustration by Ola Lundström]*

Such data have all been used in our study, and our conclusions are that Linnaeus actively tutored his students from a passive, learning-by-receiving situation into an active, learning-by-doing situation. The students thus matured to take relatively independent decisions and perform research that benefited both their own and Linnaeus' goals. This tutoring model is illustrated in Figure 1.

#### Linnaeus' own version

Linnaeus stated his views on teaching in his autobiographies intended for the posthumous eulogies given in the Swedish Royal Academy of Sciences. He wrote of himself in third person: "A professor who is to cultivate talents can not distinguish himself more at his profession than through gathering alert students and encouraging them, wherein the greatest art is the *selectu ingeniorum* [the selection of the gifted], because the true originals or observers are among the others like comets are among the stars."<sup>2</sup> This observation shows that he found it important to identify brilliant students to give them extra encouragement and to support them during their academic growth into full professionalism. If there was a student in the audience who showed interest in and a talent for botany and natural history, he encouraged him. However short of time he was, he always answered his questions, and he inspired him to further studies and to come back again.<sup>3</sup> It seems that Linnaeus had an ability to make promising students feel acknowledged and seen, and that he supported them to increase their knowledge.

According to Linnaeus himself, he fulfilled his teaching duties as

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<sup>2</sup> Letter L1397 on <http://linnaeus.c18.net> from Linnaeus to the Swedish Royal Academy of Sciences 1732.

<sup>3</sup> Fries, *Linné. Lefnadsteckning*, vol. II, 1903, p. 25.

a professor and “he never cancelled a lecture”.<sup>4</sup> He was as intense in his private lectures. In a letter written in July 1766 to his best friend and colleague, Abraham Bäck, he stated: “I now live continuously over the summer in the countryside. I have 5 students living here on the neighbouring farm, to whom I lecture three to four hours at a time twice a day...”<sup>5</sup> The private lectures gave an attractive extra income to Linnaeus, but also a great interest may be interpreted from the many hours he spent on teaching.

Linnaeus’ interest in teaching could have its origin in childhood. His interest in learning the names and characters of plants awoke when he saw his father lecturing on plants to a group of friends in a meadow. Although only four years old, Linnaeus decided there and then to learn the name of every plant he saw, and he was constantly encouraged in this learning process by his father. At eight years of age, he was teaching names of plants to his smaller sisters and to the neighbours’ children. However, this positive experience of learning was brutally interrupted when he got his first tutor outside of home. The somewhat older tutor punished him physically when his answers were wrong, and Linnaeus learnt in this negative way that it was not possible to create a will to learn through punishment.<sup>6</sup>

### Lecturing

The general teaching situation in the eighteenth century was lecturing. The students sat passive and perceptive, ready to annotate important sentences from the teacher, who read out loud from a manuscript. The students’ protocols were the main course readings.

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<sup>4</sup> Malmeström & Uggla, *Vita Caroli Linnaei*, 1957, p. 44.

<sup>5</sup> Letter L3776 on <http://linnaeus.c18.net>

<sup>6</sup> Malmeström & Uggla, *Vita Caroli Linnaei*, 1957, p. 91.

Therefore, slow reading and meticulous writing was the general method.

Things were different when Linnaeus lectured. Linnaeus wrote that “he mixed in amusing things into his lectures to liven up his audience”<sup>7</sup> and that “he always encouraged his audience to listen to the lectures with joy and pleasure”,<sup>8</sup> a remark showing that this was a conscious method in his teaching. Students bore witness of an extraordinary experience when listening to Linnaeus:

Everything that Linnaeus said was like a novelty. He could present botany and natural history like a new and almost unknown field. In Sweden, to see a rose from the Cape, a snake from Africa, an *Amaryllis* from Asia and parrots from America was like a miracle.<sup>9</sup>

Such lecturing in medicine was unheard of before. The limits for exploration were not the borders of Sweden. Every corner of the world was awaiting a natural history researcher to harvest and describe its hitherto unknown species.<sup>10</sup> Linnaeus’ rhetoric was part of his work to transform botany and zoology from a part of historiography to a proper science, a *Scientia Naturalis*.<sup>11</sup> But it was not only the contents of the lectures that influenced the audience, it was also the way it was performed. According to the student Johan Gustaf Acrel, Linnaeus did not have a strong voice, and he had a marked dialect from the province of Småland in southern Sweden. In spite of this his words got through to the audience according to

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<sup>7</sup> Malmeström & Uggla, *Vita Caroli Linnaei*, 1957, p. 187.

<sup>8</sup> Malmeström & Uggla, *Vita Caroli Linnaei*, 1957, p. 144.

<sup>9</sup> Melanderhjelm 1783, in Fries, *Linné*, 1903, vol. II, p. 5.

<sup>10</sup> See for example Hodacs & Nyberg, *Naturalhistoria*, 2007, and Sörlin & Fagerstedt, *Linné och hans apostlar*, 2004.

<sup>11</sup> Ekedahl, ‘Collecting Flowers’, 2004, p. 54.

Acrel:

He knew how to give the words in his short sentences a stress through expressions, so that no one could avoid being convinced by what he pictured. Those who heard his lectures on the introduction to *Systema Naturae*...became more moved than they were by the most beautiful sermon.<sup>12</sup>

Furthermore, Linnaeus did not read out loud from a manuscript. Acrel wrote that he could give a long lecture from a small draft: "His lectures were written on a narrow sheet of paper, which he held between his fingers and marked the end with his thumb." These drafts were previously known only from Acrel's citation. During our research we found in the archive of The Linnean Society of London narrow sheets of paper with short notes on, which we interpret as being Linnaeus' drafts from his lectures.<sup>13</sup> This supports the statement that Linnaeus lectured mainly from memory, which must have been very unusual and is today regarded as the best method of communicating with an audience.

As he was able to talk free from manuscripts, with a fascinating intonation, about new and attractive facts in nature, it is not surprising that Linnaeus attracted many students to his lectures. He noted himself that "he had a larger audience than other professors, he attracted several students from abroad. Such had never been seen at this university."<sup>14</sup> In his biography of Linnaeus, Thore Magnus Fries calculated the number of people in Linnaeus' audience. In a time when Uppsala University had 500-600 students, Linnaeus had 50-60 students listening to his lecture series *Philosophia Botanica* and *Systema Morborum* (classification of diseases), and

<sup>12</sup> Fries, *Linné. Lefnadsteckning*, vol. II, 1903, p. 7.

<sup>13</sup> The Archives of the Linnean Society of London. Linnaeus Pater. Botany.

<sup>14</sup> Malmeström & Uggla, *Vita Caroli Linnaei*, 1957, p. 187.

100-145 students to his lectures in *Diaeta Naturalis*. Linnaeus noted in the student lists that he had even more students attending who did not sign in.<sup>15</sup> At this time, the Faculty of Medicine had a maximum of 24 students. Thus, Linnaeus attracted students from other parts of the university, predominantly from the theological faculty. The maximum number of students attending a lecture by Linnaeus was 239 in 1760. However, during that time, around 1500 students enrolled in Uppsala University in an attempt to avoid being sent to the Pomeranian war, which lasted from 1757 to 1762.

#### The garden as a lecture hall

To illustrate his lectures in botany, Linnaeus often had plants brought in from the botanical garden to the lecture hall.<sup>16</sup> He preferred the students to see the scientific objects he mentioned in his lectures. To diminish the risk of plants being damaged during transport, he would rather lecture in his official professor's residence, situated in the Botanical Garden *Hortus Upsaliensis*. This approach is interesting, since it shows a will to include objects from nature in the lecturing situation. The next natural step was to bring the students into the garden.

Like other botanical gardens in Europe, *Hortus Upsaliensis* was made for teaching only and was not open to the public. When Linnaeus took over the professorship in practical medicine at Uppsala University in 1741, he also altered and extended the botanical garden. The new architecture made room for efficient teaching.<sup>17</sup> Linnaeus argued that a garden was an excellent teaching place, because "through one single glance many more herbs are offered for invest-

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<sup>15</sup> Fries, *Linné. Lefnadsteckning*, vol. II, 1903, p. 4.

<sup>16</sup> Fries, *Linné. Lefnadsteckning*, vol. II, 1903, p. 2.

<sup>17</sup> Linnaeus, *Hortus Upsaliensis*, 1748.



tigation than if one for the purpose of studying plants had walked through the whole of Europe.”<sup>18</sup>

*Hortus Upsaliensis* was divided into two great compartments with perennials in one, and biennials and annuals in the other. In both compartments, all species were ordered according to the sexual system. In this way the students could learn classification as well as life spans of plants. There were also seasonal quarters in the garden. Close to the greenhouse, spring flowers were grown in one quarter and autumn species in another quarter. It was easy to see how the two different types of plants had specialised characters, which helped them during their special flowering times. The hedges were made up of different species in sections, in order to demonstrate the economic use of these plants. The students could easily judge from a single glance which species were most suitable for planting “living fences,” an important economic improvement in the treeless agricultural landscape in eighteenth century Sweden. There were also geographical aspects of the garden. Its borders were made up of all tree species growing wild in Sweden (including Finland at that time). A walk along the boundary of the garden was dendrologically equivalent to a journey throughout the country. Most sophisticated of all were the three ecological quarters. Linnaeus used a spring in the garden to create three aquatic environments: a river, a lake and a marsh. In each he planted species that thrived in that specific habitat. Linnaeus’ knowledge of the ecology and habitat demands of different species was well developed and often visible in his publications. It is also mirrored in Linnaean species epithets, such as *fluvatile*, *palustre*, *pratensis* and *sylvestre*,<sup>19</sup> which should be interpreted as the species thriving in these habitats

<sup>18</sup> Linnaeus, *Botaniska excursioner*, 1998 [1753], §1.

<sup>19</sup> Epithets translate: “grow in rivers,” “grow in marshes,” “grow in meadows,” “grow in forests.”

around Uppsala, but not necessarily in other parts of its distribution range.

When students spent a day with Linnaeus in the garden, they could learn a lot about each plant. From the two student protocols available from garden lectures,<sup>20</sup> we see that he could stop for a long time at one plant, telling long stories about the history of the plant and his own research on it. The direct connection between Linnaeus' research and teaching is obvious in these protocols. He did not only teach basic facts, but shared with the students the most recent developments in natural science, something that was not common in teaching at that time.<sup>21</sup> In these protocols we do not only find curious stories, as when Linnaeus reported that he let his gardener remove all fallen elderflowers, *Sambucus nigra*, so that the peacocks did not eat them and die, or patronizing statements about how the Dutch gave hundreds of varieties new species names in the *Tulip* genus ("often for merely a little spot did it get another name"<sup>22</sup>), but also unique information on Linnaeus' introduction of different species like rhubarb, *Rheum spp.*, into Sweden.<sup>23</sup>

When Linnaeus bought the estate Hammarby in 1758, he planted at least one hundred species from *Hortus Upsaliensis* around the manor. The main purpose was the establishment of a minor botanical garden.<sup>24</sup> Some plants at Hammarby were introduced for research purposes, like Russian Belladonna *Scopolia carniolica*,<sup>25</sup> but

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<sup>20</sup> Anonymous, 'Några annotationer vid Arch. Linnaei excurs,' 1759; Agardt, 'Annotata öfver Carl Linnaei Föreläsningar,' 1751.

<sup>21</sup> Hodacs & Nyberg, *Naturalhistoria*, 2007, p. 9.

<sup>22</sup> Anonymous, 'Några annotationer vid Arch. Linnaei excurs'. 1759.

<sup>23</sup> Englund, 'Rhabarber', 2004, p. 32.

<sup>24</sup> Manktelow, 'Linnés Hammarby', 2001, pp. 263-269. 'Linnés dokumentation', 2001.

<sup>25</sup> Manktelow, 'Er Scopolia', 2004, p. 40-44.

most species seem to have been introduced for educational purposes. In a document from 1765, he listed the species at Hammarby twice: once according to the sexual system and once according to life form.<sup>26</sup> This double listing may be interpreted as checklists to confirm that all classes in the sexual system and all growth forms were represented in the garden for teaching purposes. Among the plants introduced by Linnaeus to Hammarby were Wild Tulip, *Tulipa sylvestris*, Hazelwort, *Asarum europaeum*, Pride of Ohio, *Dodecatheon media*, Crosswort, *Cruciata laevipes*, and Barrenwort, *Epimedium alpinum*,<sup>27</sup> all used in the *Hortus Upsaliensis* lectures.<sup>28</sup> As he spent most summers at Hammarby giving private lectures up to eight hours per day, a great number of introduced species was needed.<sup>29</sup>

#### Excursions in the wild

To study plants in the garden was not enough to get a thorough knowledge about botany, according to Linnaeus, who wrote: “During excursions one may see every plant in its natural habitat, from which a mindful observer may not only get a great pleasure, but also a more thorough knowledge about the plants.”<sup>30</sup>

According to student protocols, the excursions, named *Herbationes Upsalienses*, were the very last lectures of spring courses in botany or natural history given at the university. They generally started in April or May and ended in early July. They took place on

<sup>26</sup> Gertz, ‘Linnés blomsterrabatter’, 1927.

<sup>27</sup> Manktelow 2001, ‘Linnés Hammarby’, pp. 290, 227, 295, 282. *Dodecatheon* is mentioned in Gertz, ‘Linnés blomsterrabatter’, 1927, p. 51.

<sup>28</sup> Anonymous, ‘Några annotationer vid Arch. Linnaei excurs’, 1759.

<sup>29</sup> See footnote 5.

<sup>30</sup> Linnaeus, *Botaniska excursioner*, 1998 [1753], §1.

Wednesdays or Saturdays, days when midday prayer was not compulsory. The rules for the excursions were strict and Linnaeus described them in *Philosophia Botanica*.<sup>31</sup> In a thesis, *Herbationes Upsalienses*,<sup>32</sup> assumed to be written by Linnaeus and defended by Anders Niclas Fornander in 1753, the excursion routes were described and plant species listed. Around a dozen student protocols are available in archives, and a number of students participating in the excursions have given personal descriptions of them. From these sources we have quite a clear picture of *Herbationes Upsalienses*, as described below.

*Herbationes Upsalienses* consisted of eight excursion trails. Similar vegetation types were present on more than one trail. Thus, each vegetation type could be studied throughout the spring and summer seasons, and after eight excursions most plants and animal species around Uppsala had been seen. The clothing should be purposeful and loose-fitting. The students should bring proper reference works and collection devices into the field. The group met up at one of the town gates at six or seven o'clock in the morning, and Linnaeus assigned some of the students certain functions. One student's task was to see to it that the strict rules were followed and punish those who disobeyed or walked too slowly. Another student's task would be to shoot all interesting birds observed during the excursion for species determination. A third student became the secretary, annotating every word uttered by the teacher during the excursion. His notes were distributed afterwards to the other students for copying.

During the excursion, the students divided into groups to collect plants, animals and minerals, although plants dominate the protocols. Every half hour, Linnaeus demonstrated their findings by a

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<sup>31</sup> Linnaeus, *Philosophia Botanica*, 1751, p. 293.

<sup>32</sup> Linnaeus, *Botaniska excursioner*, 1998 [1753].

short lecture on each species. There is no evidence that Linnaeus collected species himself or dominated the discovery phase of the excursion. He seems to have activated the students constantly to collect specimens themselves on every excursion, year after year. This must have been very unusual. Even today, in a time when we like to put forward our modern methods of teaching, my experience is that botany teachers rarely step aside to activate the students fully in every excursion.

Ethnobotany and economy dominate the protocols, and there are surprisingly few details on how to recognize a species. Every plant name is shortened to its genus name and a number referring to its position in *Flora Svecica*.<sup>33</sup> This reference might be a reason for omitting taxonomic information in the hastily written protocol, as it easily could be found in the literature brought to the field.

To have excursions around a university town in Europe was by no means a novelty in Europe. In Uppsala, such had been known since the seventeenth century, and Linnaeus admitted that he copied similar excursion routes in Paris, London, Göttingen and Halle.<sup>34</sup> The distinguishing character of *Herbationes Upsalienses* was the systematic method that formed them into an efficient learning environment, just like garden architecture formed *Hortus Upsaliensis* into an efficient learning environment. The focus of each student was maintained through the clear rules and efficient organisation, for example through assigning one student to do the annotations. The strict regulations were contrasted by letting the students discover the flora and fauna by themselves.

The protocols are presumably very careful citations of Linnaeus more or less spontaneous teaching in the field. We find a great

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<sup>33</sup> Linnaeus, *Flora Svecica*, 1745.

<sup>34</sup> Linnaeus, *Botaniska excursioner*, 1998 [1753], §2 and 3. Cf. Hodacs & Nyberg, *Naturalhistoria*, 2007 p. 48, note 33 and references given there.

sense of humour, for example in the story about how the Annual Knawel, *Scleranthus annuus*, got its Latin name according to Linnaeus:

When naming this plant, Tragus, who was a professor in Leipzig, asked a Swedish student who was not a botanist. He answered, “*Knäfvelen vet*” [the Devil knows], which the professor accepted and gave the species the name “*Knävel*”. The Dutch printer omitted the dots above *ä*, and it became *Knavel*. The Archiater [*i.e.* Linnaeus] could not stand this name, but called the whole genus *Scleranthus*.<sup>35</sup>

A story like this guaranteed that the students did not forget the name of this dull, small, green-flowered plant. A short end-note in another protocol gives us information about a teacher with great patience and a will to help the less-talented students.

Our Professor, who, all along the route with remarkable indefatigability and patience questioned the less prominent students between each demonstration about the encountered and already examined plants, continued now during our return with the same work, and on the adjacent hills rather many plants were sharpened into the memory of the students.”<sup>36</sup>

This notation was made at the very end of a whole day’s excursion to Husby, North of Uppsala. The group had walked over 20 km, and was now approaching Uppsala in the evening. Linnaeus had been teaching for twelve hours, with an afternoon rest of two hours and a social dinner in a colleague’s home. To anyone who has ever been involved in teaching botany in the field, repeating

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<sup>35</sup> Anonymous, ‘Protocoller wid Linnaei excursioner’, 1760.

<sup>36</sup> Anonymous, ‘Den 5 Botaniska Excursion den 15 Junii 1754. Til Husby’, in last paragraph.

species in such a situation must be seen as a very strong teaching commitment, reflecting not only a passion for teaching, but also a passion for creating a will to learn.

Linnaeus could make use of the excursions to select talented students capable of doing good research in natural history. Those would become visible (“like comets among stars”<sup>37</sup>) while collecting species, creating Latin descriptions for species new to science, gathering their own private collections and speaking informally with the teacher in the field. To spur on the most talented students and to increase generally the will to learn, Linnaeus let those who found the rarest and most interesting species sit with him at the table at the afternoon dinner offered by academic colleagues living along the excursion trail. The others had to stand, promising themselves that next time they would work hard enough to be selected for this rare treat.

As pointed out in a recently-published book in our research project on eighteenth century scientific travel, by Hanna Hodacs and Kenneth Nyberg,<sup>38</sup> *Herbationes Upsalienses* were used not only as field lectures, but as a preparation for the students’ further educational travels within and outside of the country. In the field it was easier to create a good atmosphere between teacher and students. A story told by Friedrich Ehrhart, a student from Germany who attended Linnaeus’ lectures in Uppsala from 1773 to 1776, illustrates the informal and open relationship that could exist between Linnaeus and his students. Ehrhart was very eager in his studies, and sometimes he even criticised Linnaeus taxonomic decisions. Ehrhart wrote:

He [Linnaeus] was then usually taken aback, as for example

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<sup>37</sup> See reference to note 2.

<sup>38</sup> Hodacs & Nyberg, *Naturalhistoria*, 2007, chapter 3.

when I said that his *Carex uliginosa* and *Schoenus compressus* were the same species, and he could even exclaim “May the devil take me if this is true!”, but he would soon render me justice, so that when I returned after one or two days he would call at me: “You were right!”<sup>39</sup>

There are some very surprising elements in this story. The first is that Ehrhart dared to give his teacher scientific criticism. We do not know if this happened in front of other students, but it could well have done. In the early 1770's, Linnaeus was a world famous scientist, elected into different academies around the world and somewhat of a legend in the scientific world. In spite of this, he is addressed in an almost cheeky way by a thirty-five year younger student. However, the exclamation from Linnaeus is not grumpy, but reflects a great sense of humour and has an air of close friendship. Linnaeus rejects the criticism of having described one species as two, even belonging to two different genera. These two species had been described by Linnaeus around twenty years earlier in *Species Plantarum*, 1753. I would assume that for any taxonomist such criticism would be embarrassing. However, the most astonishing part of the story is that Linnaeus admits to Ehrhart that he was right, after having checked the species himself. It is not difficult to understand the confirmative effect that Linnaeus' comment must have had on Ehrhart at that moment and the status he earned among the group of students.

The good interaction that Linnaeus managed to create between himself and his students promoted both his teaching and his science. We can see an example of this in the development of his binomial nomenclature, the “trivial names.”<sup>40</sup> Linnaeus initially used

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<sup>39</sup> Fries, *Linné. En lefnadssteckning*, vol. II, 1903 p. 23-24.

<sup>40</sup> Jonsell, ‘Linnaeus at his zenith’, 2003, pp. 12-14. Nyberg & Manktelow, ‘Linnés apostlar och tillkomsten av Species plantarum’, 2003, pp. 21-24.



trivial names in the field together with his students during the journey to Öland and Gotland. They then appeared in the most brilliant students' theses, were later applied in the *Herbationes Upsalienses*<sup>41</sup> and finally published in *Species Plantarum* in 1753. It is clear that Linnaeus tested the trivial names in his group of students before final publication.<sup>42</sup> Moreover, we have argued in our research project that *Species Plantarum*, a fundamental work marking the scientific starting point of modern systematic botany, was not one man's work but, to a certain extent, a product of the interaction between Linnaeus and his students<sup>43</sup>

It is therefore time to abandon any interpretation of Linnaeus' excursions around Uppsala as merely a romantic dwelling in nature. We would rather describe them as an organized tutoring stage, where the transforming of students into independent scientists began in a serious way. *Herbationes Upsalienses* were a first expedition into nature, in a safe, controlled manner.<sup>44</sup>

#### Expeditions great and small

Linnaeus' tutorship did not end with the student's doctoral degree. For those who were selected as talents by Linnaeus and suitable for continuing their careers, the opportunity would now appear for an expedition to botanically unexplored countries. But before this great challenge, it was important to further mature and sharpen the skills for scientific travels by a minor expedition within the country.

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<sup>41</sup> Anonymous, 'Botaniskt protokoll hållit wid Excursion d. 22 Maji 1752', Linnéan Society.

<sup>42</sup> Nyberg & Manktelow, 'Linnés apostlar och tillkomsten av *Species plantarum*', 2003, pp. 21-24.

<sup>43</sup> Manktelow & Nyberg, 'Linnaeus' apostles and the development of *Species Plantarum*'. 2003, pp. 79-80.

<sup>44</sup> Hodacs & Nyberg, *Naturalhistoria*, p. 57.

To explore Sweden's natural resources, new species and cultural varieties were central to Linnaeus as well as to the Royal Swedish Academy of Sciences and the Swedish state at that time. Linnaeus' personal interest and involvement in these matters can be seen in his choice of topic for his inaugural lecture after being appointed professor of medicine at Uppsala in 1741: "On the necessity for scientific travel within the country."<sup>45</sup>

Journeys within the country could be performed in different ways. The student could accompany younger trainees on their educational tours, he could follow Linnaeus on his major travels as an assistant, or he could perform an independent journey similar to the one Linnaeus did in Lapland in 1732.<sup>46</sup> In whatever way national travel was carried out, the results and experiences were valuable both to the student and to Linnaeus, who got the opportunity to judge whether the person was mature enough to make a greater expedition abroad. One could imagine that the students would be the most eager to get away on an expedition, but the 'apostles', as the travelling students of Linnaeus were known, were as different as they were many. The very first traveller, Christopher Tärnström, was extremely eager to travel, although Linnaeus was doubtful because of his age (he was 39) and was the father of several children. The death of Tärnström on an island off the coast of present-day Vietnam proved Linnaeus right, and gave him a sad experience which would be important for future decisions. On the other hand, the talented Pehr Kalm, who had Linnaeus' friend Sten Carl Bielke as his main patron, could not decide his target country. When he mentioned a planned trip to China to Linnaeus, Kalm described in a letter to Bielke how not he, but Linnaeus, got so happy that he

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<sup>45</sup> Linnaeus, *Oratio de necessitate peregrinationum intra patriam*, 1743, Swedish transl. by Annika Ström in Hodacs & Nyberg, *Naturalhistoria*, 2007, pp. 183-198.

<sup>46</sup> Hodacs & Nyberg, *Naturalhistoria*, 2007, chapter 3.

jumped up and down in the room with excitement and gave Kalm a great deal of good advice on how to proceed with the project.<sup>47</sup>

The educational perspective of natural history expeditions is treated in detail in the book by Hanna Hodacs and Kenneth Nyberg, and only fragments of those findings may be referred to here. One interesting result of our research project is that the students travelling abroad were a heterogeneous group of students with different personal motives and varying levels of support from Linnaeus. The students travelling to foreign countries did so over a span of fifty years.<sup>48</sup> After having finished a successful journey, they could often use it to advance their careers. They could use their collections and knowledge for publications and communication in the scientific community. An example is Carl Peter Thunberg, who after nine years in South Africa, Sri Lanka, Indonesia and Japan returned home to Uppsala, arriving right after Linnaeus' death. Carl Linnaeus, the younger, was his father's successor on the professor's chair, and, after his death in 1784, Thunberg took over the professorship and the responsibility for the botanical garden and the natural history collections. Linnaeus' private collections had been sold to London, and the remaining items belonging to the university were severely damaged by moisture and vermin. Thunberg donated his own large collections to Uppsala University, and these became the starting point of the current natural collections. He spent the rest of his life in Uppsala, sorting and describing his specimens and interacting with other scientists. His collections became an important stepping stone from Linnaeus to the current research in biology at Uppsala University, and they are today of utmost importance to scientists working with Japanese flora.

The careers and aftermaths of the students may partly reflect

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<sup>47</sup> Kalm, *Pebr Kalms brev till friherre Sten Carl Bielke*, 1960, pp. 67-70.

<sup>48</sup> Hodacs & Nyberg, *Naturalhistoria*, 2007, p. 138.

successful teaching and mentorship by Linnaeus. His students used his methods and grew into independent, creative scientists. During the Linnaeus Tercentenary celebrations in 2007, the students' splendid careers became visible in local celebrations in parishes and towns connected with their persons. We were reminded of Peter Hernquist, the father of veterinary science, Eric Acarius, the father of lichenology, Johann Fabricius, the father of insect systematics, Pehr Kalm, the Linnaeus of Finland and explorer of America, Thunberg, the Linnaeus of Japan, and Anders Sparrman, no father in science but with a glowing pen.

Those of Linnaeus' students who did not travel abroad to write themselves into the history book as apostles of Linnaeus became vicars and medical doctors in parishes all around Sweden. They are today little known, but constituted the majority of students attending Linnaeus' courses. They spread the teaching and research methods they had learnt in Uppsala among parish members. They explained the flora and fauna of Sweden and collected species to send to Linnaeus and other colleagues. The impact of Linnaeus' teaching methods on a national level is more or less immeasurable, but one may speculate that these relatively unknown scholars of Linnaeus were the ones who transformed Sweden into a country of knowledge in taxonomy and natural history. Thousands of school children had their summer vacations destroyed or enlightened by compulsory collection of 100 plant species, correctly mounted on herbarium sheets, a requirement that extended into the 1950's. Sweden is today a country where university students still count stamens and pistils in the main national flora used in higher education,<sup>49</sup> although the sexual system has already been replaced in the

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<sup>49</sup> Swedish university botany students generally use Krok, T. & Almquist, S. *Svensk Flora*, which still has a determination key that starts with Linnaeus' sexual system.

late eighteenth century by the natural system worked out by Antoine-Laurent de Jussieu in France.<sup>50</sup> Swedish parents currently express a concern that children do no longer learn enough names of trees and flowers in the schools.

### Not only men, but women

It is interesting to note that the educational sphere around Linnaeus did not, as one might have expected, consist exclusively of men. The academic world was not open to women, but there were several contacts between Linnaeus and talented women more or less educated in science.<sup>51</sup> The sexual system was easy to learn, especially after Linnaeus had translated it into Swedish in 1753.<sup>52</sup> The translation was dedicated to Ulla Sparre, the wife of the leading Swedish politician Carl Gustaf Tessin, whom Linnaeus had known since his time in Stockholm in 1739. Sparre was interested in natural history, kept a herbarium classified according to Linnaeus' system, and had a library larger than her husband's. Linnaeus provided Sparre with seeds for her garden in Åkerö. He communicated, too, with other knowledgeable women in Sweden and Europe, for example: Elsa Beata Wrede, who started large experimental plantations and tried out vineyards in Sweden; Lady Anne Monson, who translated Linnaeus' sexual system into English and helped to pave the way for his system in the British Empire; Jane Colden, known as America's first female botanist; and Caroline Luise von Baden-Durlach, a highly educated natural historian with collections grand enough to constitute the basis of the Museum of Natural History in

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<sup>50</sup> Jussieu, *Genera Plantarum*, 1789. Jussieu's system influenced subsequent systems and became a foundation of modern plant systems.

<sup>51</sup> This chapter is built on Manktelow & Kettunen, *Kvinnorna kring Linné*, 2007.

<sup>52</sup> Linnaeus, *Indelning i örtriket*, 1753.

Karlsruhe, Germany.

Linnaeus was apparently very encouraging in his attitude towards these women. He praised the female mind as being more suited for long-term commitments like plantation experiments, because “what they desire to do, they desire heavily, and their inclination does not expire like men’s.”<sup>53</sup>

Science was not performed solely in the academic environment of the eighteenth century, but also in the home. Linnaeus held private lectures in his home, let students live with the family, and discussed science with invited colleagues and guests at the dinner table. There were four daughters in Linnaeus’ family who could all learn in this way although they never attended school. Linnaeus communicated with his daughters already when they were young. They dictated letters and he wrote the words down, he took them to meet his students, and he took walks with them in town. The oldest daughter, Elisabeth Christina Linnaea, seems to have had a scientific mind. At nineteen, she published a paper in the Proceedings of the Swedish Royal Academy of Sciences about an observation of flashes in the Nasturtium flowers, *Tropaeolum majus*.<sup>54</sup> Linnaeus encouraged her to write, and probably also mentored her in transforming the observation into a written report. This encouragement was in line with the aims of the Academy of Sciences, founded by Linnaeus and other scientists, which was to expand the limits of scientific exploration beyond the academic territory into the domain of laymen, including women.

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<sup>53</sup> Cited in Manktelow & Kettunen, *Kvinnorna kring Linné*, p. 25. Letter nr L4158 on <http://linnaeus.c18.net>

<sup>54</sup> Linnaea, ‘Om indianska krassens blickande’, 1762.

### Can we apply Linnaeus' methods today?

Based on our research results, the hypothesis about Linnaeus' capability to teach is that he had clear teaching and tutoring methods resulting in good mentorship during the metamorphosis of the student from an immature beginner into a fully educated mature scientist. Apart from tutoring talented students in this way, he also cared about the less-talented students' learning. He got a high score in qualities we use today to describe a good teacher. We could characterize Linnaeus as knowledgeable, stimulating, enthusiastic, activating, structured, clear in speech, explanatory, pedagogic, communicative, open to criticism, conscious, secure, awe-inspiring, humorous, pleasant, and having a good confidence.

Is it possible to be inspired by Linnaeus' teaching in a modern teaching situation? Our answer to that question is, yes we may be inspired by Linnaeus. A short list of applied Linnaean teaching methods for today could be:

- Know your subject.
- Structure your lectures.
- Train in rhetoric.
- Speak without manuscript.
- Stimulate your students into "learning-by-doing."
- Create a will to learn.
- Mentor talented students as well as those who need support to learn.
- Listen to the students.
- Understand the connection between teaching and the progress of your science.
- Use your sense of humour.



*Fig. 2. To the Linnaeus Tercentenary in 2007 guides were educated in Linnaeus' teaching methods. They dressed up in eighteenth century style clothes and had excursions on the restored excursion trails of *Herbationes Upsalienses*. [Photograph by Bjorn Tingstrom]*

Since 2002, a course called “Linnaeus: Life and Sciences” has been given at Uppsala University to test the results from our research project.<sup>55</sup> In this course, known qualities of Linnaeus as a teacher have been brought “alive.” The teachers selected are all “good teachers” with a great enthusiasm for their science. They have been encouraged to use “old-fashioned” methods in teaching, *e.g.* their voice only. Talks given by Linnaeus have been read out loud by an actor in a lecture hall used in the 1740's for medical lectures. The students have been prepared with a thorough lesson in

<sup>55</sup> Course description at: <http://www.ibg.uu.se/linnaeus/Internet/index.html>



rhetoric and have made a rhetorical analysis of the speech. On the authentic trails of *Herbationes Upsalienses*, the students have made excursions with a botany teacher, collected species and listened to quotes by Linnaeus from eighteenth century protocols with a subsequent historic interpretation of words and concepts.

The course was valuable in the preparation of the 2007 Tercentenary celebrations when, for example, the *Herbationes Upsalienses* around Uppsala were restored with new information signs and a new web-page. A group of guides were trained in Linnaean teaching methods on the university course. They dressed up in eighteenth century-style clothing with the main task of creating curiosity and made walks for children and adults that ran throughout the year and have continued after that (Figure 2).

In conclusion, we find it inspiring and satisfying to be able to apply our research results directly onto contemporary teaching situations, especially in an area marked by the cultural and scientific history of Linnaeus' life and work. To apply our science in this way was also the goal of our funding institution. However, the group we hope will gain most from these applied results are the children arriving in Uppsala to ramble on *Herbationes Upsalienses* or being taught by teachers who have been inspired by Linnaeus.

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