

The challenge of colour: Eighteenth-century botanists and the hand-colouring of illustrations

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Abstract

Colourful plant images are often taken as the icon of natural history illustration. However, so far little attention has been paid to the question how this beautiful colouring was achieved. At a case study of the eighteenth-century Nuremberg doctor and botanist Christoph Jacob Trew the process of how illustrations were hand-coloured, who were involved in this work and how the colouring was supervised and evaluated is reconstructed, mostly based on Trew's correspondence with the engraver and publisher of his books, Johann Jacob Haid in Augsburg. Furthermore, the question of standardising colours, their uses and their recipes is discussed at two examples of the same time period: the colour charts of the Bauer brothers, arguably the most renowned botanical draughtsmen of the period, and the colour tables by the Regensburg naturalist Jacob Christian Schaeffer. Hand-colouring botanical illustrations, it is argued, was far from a straightforward task but confronted botanists and their employees with a plethora of practical and methodological problems, to which different solutions were developed in the course of time. Analysing these problems and solutions reveals some new and interesting aspects of the practices of eighteenth-century botany and of the production of scientific illustrations in general.

Keywords

Natural history, eighteenth century, history of biology, Linnaean botany, scientific illustrations

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1. Introduction

‘Colour is remarkably changeable, and so is of no value in definitions’, Carl Linnaeus wrote in his theoretical treatise on the taxonomy of plants, the *Philosophia Botanica* (1751).¹ Linnaeus rather advised that – at least theoretically – only four dimensions should be taken into account when defining a taxonomic category: a plant’s organs’ number, shape, position and proportion; since, as he explained, ‘these [four dimensions] are constant everywhere, in the plant, in the herbarium, in an illustration’.² Linnaeus had good reason to assume that colour did not fulfil this condition: no guarantee could be given for its constancy, not even – as one would be inclined to think – in illustrations. While most botanical illustrations of the period of Linnaean botany, that is, the mid-eighteenth to the early nineteenth centuries, were published hand-coloured, this practice confronted botanists and draughtsmen of the time with considerable practical and methodological problems. To illustrate this claim, in the following sections I shall give a reconstruction of the working steps involved in the colouring of illustrations, at the example of the *Plantae Selectae*, the most ambitious project of the Nuremberg editor of illustrated botanical works, Christoph Jacob Trew. In view of these findings, I shall then discuss the problems of colour standardisation, prevalent in the eighteenth century, and two attempts to solve them.

2. The making of a hand-coloured botanical illustration

2. 1 The *Plantae Selectae*

Today, Christoph Jacob Trew (1695-1769) is well known as an enthusiastic collector of books, pictures, natural history objects and letters (written by himself, correspondents and other scientists). Trew was a doctor by profession and worked in Nuremberg as a general practitioner, besides being an active member of the local *Collegium Medicum*, a kind of physicians’ guild, and publishing his own medical professional journal as well as the journal of the German Academy of Naturalists (the Leopoldina).³ Notwithstanding all these obligations, Trew gave a large part of his time, energy and attention to the making and publication of plant illustrations.⁴ Presumably, the most famous among the many

¹ Cited Carl Linnaeus, *Philosophia Botanica*, translated by Stephen Freer (Oxford, 2003), 229, paragraph 266. The original Latin text reads: ‘Color in eadem specie mira ludit, hinc in differentia nil valet.’ See *ibid.*

² See Carl Linnaeus, *Philosophia Botanica* (Stockholm, 1751), 224, paragraph 282. Original Latin: ‘*Modi*, quibus differentia desumitur, sunt quatuor: *Numerus*, *Figura*, *Situs*, *Proportio*, adeoque iidem, qui in genere. Hi ubique constantes, in planta, in Herbario, in Icone.’

³ The part of Trew’s collections to have survived is now held in the University Library Erlangen (Germany). An extensive catalogue to the Trew Collection of Letters (TCL) was published in Eleonore Schmidt-Herrling, *Die Briefsammlung des Nürnberger Arztes Christoph Jacob Trew (1695-1769) in der Universitätsbibliothek Erlangen* (Erlangen, 1940). The numbering system established in this catalogue has been used for all letters referred to in this paper. On Trew in general, see, e.g. Julius Pirson, ‘Der Nürnberger Arzt und Naturforscher Christoph Jacob Trew (1695-1769)’, *Mitteilungen des Vereins für Geschichte der Stadt Nürnberg*, 44 (1953), 448-575; Dieter Schug, ‘Christoph Jacob Trew’, *Fränkische Lebensbilder* 8 (1978), 130-46; Thomas Schnalke (ed.), *Natur im Bild. Anatomie und Botanik in der Sammlung des Nürnberger Arztes Christoph Jacob Trew* (Erlangen, 1995); Thomas Schnalke, *Medizin im Brief* (Stuttgart, 1997).

⁴ See among others: Christoph Jacob Trew, *Herbarium Blackwellianum emendatum et auctum [...] -- Vermehrtes und verbessertes Blackwellsches Kräuterbuch* (Nürnberg, 1750-73); Christoph Jacob Trew, *Plantae selectae: per decades editae. Quarum imagines ad exemplaria naturalia Londini in hortis curiosorum nutrita manu artificiosa doctaque pinxit Georgius Dionysius Euret Germanus [...] Augsburg*, 1750-73); Christoph Jacob Trew et al., *Hortus Nitidissimus omnem per annum superbiens floribus[...] -- Der das ganze Jahr hindurch in schönstem Flor stehende*

draughtsmen that were working for Trew was Georg Dionysius Ehret (1708-1770). Ehret, born as son of a Heidelberg gardener, had started a career as a botanical draughtsman in the 1730s, which was to bring him the greatest of fame – not least due to Trew's steadfast encouragement. Trew was the first botanist that supported Ehret's artistical ambitions, and Ehret continued to work for him, if only occasionally, for the rest of his life.

The first issue of the *Plantae Selectae* appeared in 1750; however, the last was only published in 1773, already after Trew's death. His intention for this book was to publish 100 of Ehret's finest plant drawings. (Ehret had, by then, become very well known as a draughtsman of plants.) Trew had already a collection of suitable images at hand, mostly watercolour drawings executed on paper or parchment. In this first, unprinted form, botanical illustrations were offered for sale to enthusiasts and botanists, such as Trew, who collected them and, depending on their level of interest, either only admired or used them for scientific purposes. If, however, one wanted to publish these pictures, as Trew had decided, they had to be transformed into copperplates for multiple printing. For the *Plantae Selectae*, Trew managed to engage Johann Jacob Haid (1704-1767) to work with him as copper-engraver and, at the same time, publisher of the final work. Haid was regarded as one of the best copper-engravers of the time; an additional advantage from Trew's point of view was Haid's wide experience in producing natural history illustrations, since he had done a large part of the engraving and printing of Johann Wilhelm Weinmann's renowned botanical work *Phytanthoza Iconographia* (published 1735-45).⁵ There was, however, one snag in engaging Haid for the project: at the time, Trew was living in Nuremberg, Haid ran his workshop from Augsburg and Ehret was based in London. This state of affairs made the collaboration between author, draughtsman and engraver rather difficult. However, this arrangement turned out to be a stroke of luck for historians, since much of the correspondence, which out of necessity took place between the protagonists, has survived. Trew kept all the letters sent to him, plus many draft versions of his own letters, and they reveal a great deal about the project and its difficulties.⁶ Unlike the *Phytanthoza*, which was one of the first books to be produced in the technique of colour print, the plates for the *Plantae Selectae* had to be coloured by hand – 'illuminated' as it was then known -- and this was also done in Augsburg under Haid's supervision. This is the working stage on which I shall focus in the following.

2. 2 How to mix a colour: pigments and shading

Producing a hand-coloured botanical illustration was not an easy task in the eighteenth and early nineteenth centuries, even if one had the best employees at one's disposal and production went smoothly – both of which was not often the case.⁷ To start with, to achieve good results, it was essential that high-quality paper -- which, at the time, generally meant Dutch paper -- was used; this paper was not only expensive, it was also not

Blumengarten [...] (Nürnberg, 1750-86); Christoph Jacob Trew, *Plantae Rariores, quas maximam partem ipse in horto domestico coluit* [...] (Nürnberg, 1963-84).

⁵ Johann Wilhelm Weinmann, *Phytanthoza Iconographia. [...] Oder eigentliche Vorstellung etlicher Tausend sowohl einheimischer als ausländischer -- aus allen vier Welt-Theilen -- in Verlauf vieler Jahre, mit unermüdetem Fleiss [...] gesammelter Pflanzen, Bäume, Stauden, Kräuter, Blumen, Früchte und Schwämme etc.* [...] (Regensburg, 1735-45).

⁶ The correspondence between Trew and Haid, which is the focus of the analysis in this article, can be found in the catalogue to the Trew Collection, E. Schmidt-Herrling (note 3), at Trew, C. J., Nos. 256-295, and Haid, J. J., Nos. 153-311.

⁷ For an anthology of contributions on hand-coloured woodcuts and copper-engravings from the Baroque and Renaissance times, analysed from an art-historical perspective, see Susan Dackerman (ed.), *Painted Prints. The Revelation of Color in Northern Renaissance and Baroque Engravings, Etchings and Woodcuts* (Pennsylvania, 2003). The book by Cassandra Bosters et al. (eds.), *Kunst in Kaart* (Utrecht, 1989) includes a chapter on the hand-colouring of maps in the sixteenth to seventeenth centuries. A comparable study focusing on scientific illustrations (in the largest sense) of later periods has yet to be written.

easy to get hold of. Furthermore, it was almost impossible to find ready-made colours; instead, draughtsmen used natural pigments, from plants, minerals or animals, from which the colours would be mixed following their own or traditional recipes. These pigments and the other raw materials required for preparing colours were even more expensive than the paper, and often acquiring them was quite a challenge. A specific pigment of particularly good quality was a popular gift for friends and colleagues who lived in the provinces or in places where these goods were hard to find. In December 1758, for example, when the project of the *Plantae Selectae* was already under way, Trew thanked Haid for the scarlet that Haid had bought during a journey to Italy, which Trew had sent on to the draughtsman Ehret in London. This colour used to be made from the dried bodies of the female cochineal insect, and was so rare and expensive, even in London, that both Trew and Haid knew that Ehret would greatly appreciate this gift.⁸

But even if the necessary pigments were at hand, mixing colours from them was no easy matter. One had to learn to master the often toxic pigments, which required either careful guidance or years of experience. Manuals of the time regularly made allowances for these difficulties:⁹ the Dresden draughtsman Johann Christian Friedrich, for example, dedicated a whole chapter in his manual of botanical drawings to ‘The Naming and Preparation of Colours’.¹⁰ For mixing white and yellow colours he gave the following recipes:

No. 1. White. One has to use Kremnitz white,¹¹ mix it very finely into water, then one takes a little *gum tragacanth* and very little *gum arabic*,¹² both dissolved in water, so that it can still be wiped [sic] when it has dried. One should not be disturbed by that, as one never applies the white onto bare [unprepared] paper, because it easily blackens.¹³ Rather, one should always apply another colour underneath, by which it [the white] will be held if one applies it wet to the latter, so that it does not smudge. If one also paints physically, that is, if one adds or mixes white into another colour, one also has to apply a colour underneath to which no white has been added, as in Plate XXIII, figures 1 and 2.

No. 2. Fig. 1. Dark yellow, that is, gamboge.¹⁴ It is applied very thickly or in more than one layer. [...] ¹⁵ All of this gamboge should be used up at once, or one should only mix into a shell as much as one needs at a time, since every time one dissolves it, it gets even browner.

No. 3. Fig. 1. Orpiment.¹⁶ As with cinnabar, this has to be mixed very thinly into water until it is fine; otherwise it burns and is ruined. Once it is fine, one leaves it on the

⁸ See TCL (note 3); Trew, C. J. to Haid, No. 183, 9 December 1758.

⁹ So-called *Illuminierbücher* (Hand-Colouring Manuals) existed long before the eighteenth century. The best known example is probably the manual written by Valentin Boltz von Ruffach, published in 1549 and still in use 200 years later. For a reprint, see Valentin Boltz von Ruffach, *Illuminierbuch* (Munich, 1913).

¹⁰ The original German title reads ‘Benennung und Zubereitung der Farben’.

¹¹ A misuse of the term *Kremser white* (Krems is a town by the River Danube). It was an artificially produced alkaline lead carbonate, the use of which is forbidden today because of its toxicity (Formula: $\text{PbCO}_3 \times \text{Pb(OH)}_2$ or Pb_2CO_3). The dictionary by Thomas Brachert, *Lexikon historischer Maltechniken: Quellen – Handwerk – Technologie – Alchemie* (Munich, 2001) contains much valuable information on pigments that were in use until 1780; see also the website: <http://www.emrath.de/pigmente.htm> (in 2005 still maintained by Volkert Emrath, Berlin).

¹² *gum tragacanth* = white or reddish gum from plants of the genus *Astragalus*, *gum arabic* = the gum exuded by some species of acacias. Both substances are used today as thickening and gelling agents.

¹³ This pigment blackens when it comes into contact with hydrosulphides, which are present in paper, so that the white would become black if applied directly to the paper.

¹⁴ A natural resin from the *Garcinia morella* tree. Toxic (today used in low concentrations as a purgative).

¹⁵ In the paragraph omitted here, two lighter shades of the dark yellow colour are described.

¹⁶ Highly toxic pigment of bright yellow colour that consists of arsenic (As_2S_3). Boltz von Ruffach commented: ‘This is also a worrying (but beautiful) colour. When you grind it, cover your mouth and nostrils, so that you do not inhale any steam and dust. [...] And take care that you do not lick a brush of this colour, since it is harmful.’ Original German: ‘Diss ist auch ein sorgliche (doch schöne) Farb. Wann du die rybst, so

colouring stone until it has lost all its superfluous liquid; then one only adds as much *gum arabic* until it cannot be wiped [sic]. Here, I still have to recall the following: if one wants to use both¹⁷ these colours safely, one has to put them in *aqua fortis*¹⁸ after they had been mixed into water but before the gum has been added, and leave them to burn off. Then one neutralises [them] again with water, until no *aqua fortis* can possibly be left, and only then does one add the gum.¹⁹

For each of the recipes in his list Friedrich referred to a detail in the accompanying plate, where an example of the colour mix in question was provided. But even if one had correctly carried out the instructions of these recipes, the task was not yet over: the next section of the chapter dealt with the ‘Shading of the Tints or Colours’.²⁰ This topic is discussed in no less detail than the recipes themselves, since frequently it was only through combining different colours that the desired nuance was attained -- and here again, Friedrich regularly referred to the plates of colour samples printed in his booklet. As with the recipes, only a few examples are given here; the numbers refer to the basic recipes that Friedrich had introduced earlier (see quote above; 1 = white, 2 = dark yellow, and so on):

White, Plate XXIV, fig. 1. This is to be shaded with Indian ink, namely with 1 lightly applied, then shaded with 2, upon which the strongest effects are made with 3 [...]; this makes them not appear hard or cold.

Dark yellow, fig. 2. is first shaded with orpiment, then, second, with ox gallstone. Dark yellow ochre can replace it, if the latter is not available.

Light yellow, fig. 3. is first shaded with dark yellow, then, second, with dark yellow ochre.

Pale yellow, fig. 4. This is first shaded with lighter yellow, then, second, with a blackish colour, and third the shadows are worked over with a greenish shade. [...]²¹

verbindt mund und nasslöcher, dass dir der Dampf und stoub nit darin riech. [...] Unnd [sic] hüt dich du kein pensel diser Farb leckest, denn es ist schedlich.’ V. Boltz von Ruffach (note 9), 71.

¹⁷ ‘Both colours’ refers to the orpiment and to the lighter shade pale orpiment.

¹⁸ This is the specific designation of nitric acid (HNO₃) in a concentration of 50 to 55 %, which was used in mints for separating silver and copper from gold alloys, and for determining the exact gold content of coins. The acid does not affect gold but it dissolves silver and copper from the alloy, with which it forms nitrates.

¹⁹ Johann Christian Friedrich, *Anweisung zum Zeichnen und Blumenmalen* (Friedrichstadt, 1786), 23ff. Original German: ‘No. 1. Weiss. Hierzu muss man Krennitzer Weiss nehmen, dieses reibt man ganz fein in Wasser, dann nimmt man etwas *Gummi Dragant*, und sehr wenig *Gummi Arabicum*, beydes in Wasser aufgelöst, dazu, so dass es sich noch etwas wischen lässt, wenn es trocken ist. Denn hieran darf man sich nicht stossen, da man das Weiss niemals auf das blossе Pappier aufträgt, weil es auf demselben leicht schwarz wird; es wird vielmehr allemal eine andere Farbe darunter gelegt, von dieser wird es, wenn man es auf dieselbe nass aufträgt, angehalten, dass sich nicht wischt. Wenn man auch körperlich malet, das ist, wenn man eine andere Farbe mit Weiss versetzt oder vermischt, muss ebenfalls eine mit Weiss nicht versetzte darunter kommen, und gerade dieselbe, so mit dem Weiss versetzt ist, wie auf Tab. XXIII. Fig. 1. und 2. zu sehen ist. // No. 2. Fig. 1. Dunkelgelb, dieses ist Gummigutti. Es wird sehr dicke, oder mehr als einmal über einander aufgetragen. [...] Diese Gummigutti muss allemal vom Stück weggemalet, oder nur so viel in eine Muschel eingerieben werden, als man auf einmal brauchet, dann so oft man sie auflösst, wird sie immer brauner. // No. 3. Fig. 1. Auror- oder Rauschgelb. Dieses muss in Wasser immer sehr dünne gerieben werden, wie der Zinnober, bis es fein ist; sonst verbrennt es und wird hässlich. Wenn es nun fein ist, lässt man es auf dem Farnestein stehen, bis es die überflüssige Feuchtigkeit verlohren hat; dann nimmt man so viel *Gummi Arabicum* dazu, dass es sich nicht wischen lässt. Noch muss ich hier folgendes erinnern: wenn man diese beyden Farben sicher gebrauchen will, so muss man dieselben, nachdem sie im Wasser gerieben worden, doch ehe noch Gummi dazu kommt, in Scheidewasser thun, und abbrennen lassen, alsdenn mit Wasser wieder absüssen, bis kein Scheidewasser mehr darinne sein kann, und dann erst Gummi dazu thun.’

²⁰ The original German title reads ‘Schattirung der Couleuren oder Farben’.

²¹ J. C. Friedrich (note 19), 26ff. Original German: ‘Weiss, Tab. XXIV, Fig. 1. Dieses wird aus Tusche schattirt, nemlich mit 1 blass angelegt, dann mit 2 hinein schattiret, drauf werden mit 3 die stärksten Forcen hinein gemacht [...]; dieses macht, dass es nicht hart oder kalt ausieht. // Dunkelgelb, Fig. 2. wird 1tens mit Aurorgelb, dann 2tens mit Ochsen gallenstein schattiret. Dunkelgelber Oker kann allemal den Mangel desselben ersetzen. // Hochgelb, Fig. 3. wird 1tens mit Dunkelgelb, dann 2tens mit dunkelgelben Oker

Thus, as can be taken from these paragraphs, the preparation of the colours and their handling were difficult tasks, and hiring unskilled workers for this job was in many cases a waste of time and money, since the results were frequently at best of dubious quality. However, having botanical illustrations hand-coloured by knowledgeable employees was a serious problem.

2.3 *Who were the colourists?*

In December 1749 Haid assured his client Trew that he had tried, albeit in vain, to finish the first ten plates of the *Plantae Selectae* by the end of the year:

The painters make things very difficult and expensive. They are admittedly hard-working and willing, but the accuracy and beauty holds them back, so that they do not achieve very much. I do hope that it will, out of necessity, become better, easier and more pleasant for them and me once the painters are used to this work and they are more familiar with the style of drawing. In the meantime, it costs me dearly, not only in terms of money but also in time and effort, that neither Your Noble Excellency nor anyone else would suspect and believe.²²

As this complaint of Haid's confirms, the time it took to colour a print by hand added considerably to the cost of manufacturing scientific illustrated works. It is not clear how many people Haid employed to paint the plates and how educated they were. For a work of similar size, for instance William Curtis's *Flora Londinensis*,²³ allegedly up to thirty colourists, men and women, were engaged, all of them closely supervised by Curtis, as he assured his readers (which one may or may not believe).²⁴ Haid probably had not as many workers employed as Curtis, although he would perhaps have enjoyed the extra hands. Colourists still had to be paid, and talented painters of scientific plant images were as hard to find as good copperplate engravers, particularly if the work was demanding. Nevertheless, in the same letter of December 1749, Haid proudly reported the following:

I have already got one of the best painters and colourists, and I am still looking for a few others, in order to get things going, since I need to have a supply of willing and hard-working people, so that I can threaten one or more with the sack if he isn't proper, attentive and hard-working.²⁵

Haid was more particular than many other publishers and authors in his choice of employees; as he explained his client, he could not 'use just any painter and illuminist but

schattiret. // Blassgelb, Fig. 4. Dieses wird 1tens mit höhern Gelb, dann 2tens mit Schwärzlich schattiret, und 3tens die Schatten mit Grünlich übergangen. [...]

²² TCL (note 3), Haid, J. J. to Trew, No. 167, 20 December 1749. Original German: 'Die Mahler machen es mir sehr sauer, und kostbar. sie sind zwar fleissig und willig, die richtigkeit und Schönheit aber hält sie eben auf, dass Sie nicht viel leisten können. ich hoffe aber nothwendig, dass wann die Mahler hierinnen geübt, und ihnen geläufiger seyn wirdt zu zeichnen, es vor Sie u. mich besser, leichter und schöner gehen werde, dieweil köstet mich es so viel lehrgeld, Zeit u. so grossen aufwand, dass es Eur. EdelExcellenz, u. niemand vermuten u. glauben wird.'

²³ William Curtis, *Flora Londinensis* (London, 1777-98).

²⁴ Gill Saunders, *Picturing Plants. An Analytical History of Botanical Illustration* (London, 1995), 128.

²⁵ TCL (note 3), Haid, J. J. to Trew, No. 167, 20 December 1749. Original German: 'Ich habe bereits einen der besten Mahler u. Illuministen, u. suche noch mehrere, um gefördert zu werden, dann ich muss willige und fleissige leuthe hiezu vorräthig haben, damit ein od. anderer den abschied betrohen kann, wann er nicht ordentlich, achtsam und fleissig seyn wollt.'

only people of intellect, compliancy and patience'.²⁶ The ability and motivation of the people taken on to colour botanical prints differed considerably, and the results varied correspondingly.²⁷ Generally, the colouring of the plates was the responsibility of the publisher (as in the case of the *Plantae Selectae*), who also had to cover the expenses for this work as well as for the making of the copperplates; whether he would be able to make up for this expenditure in the end depended substantially on how well the prints sold. And so, few publishers could afford to employ well-trained specialists to hand-colour their engravings, in addition to engaging qualified copperplate engravers. Unskilled workers were, therefore, often hired, and these were frequently women, even occasionally children. Georg Christian Oeder's *Flora Danica*, for example, was mostly painted by women, who, as Johann Beckmann reported, 'were paid 4 Stüver per Plate'.²⁸ According to Heidrun Ludwig, who conducted a thorough study of the Nuremberg tradition of natural history illustrations, Oeder employed two women colourists on a full-time basis: a Mrs. J. A. Seizberg neé Ridinger²⁹ and the wife of a Nuremberg sculptor called Starck, who had worked as painter for A. J. Rösel von Rosenhof. Together, these two women are said to have educated orphan girls, who then later worked as colourists on the *Flora Danica*.³⁰

2.4 Standards, criteria and corrections

How did one judge whether a printed plate had been adequately painted? First, this was a question of the right technique. The colours should be strong and clearly recognisable, while they were not allowed to cover the lines of the engraving.³¹ Watercolours were, therefore, primarily used and were applied either freehand or with stencils. Furthermore, the colours of the prints should in all copies of the work correspond as exactly as possible to the original work. Eighteenth-century colourists, however, did not have precise scales for measuring pigments and worked without standardised colour formulae, using only rough preparations based on natural products, as demonstrated at the Friedrich manual, which always vary in nuance and intensity. Therefore, this last condition, justified though it might have been, could not be met in practice. Even the colours of two copies of a work were almost never identical, and even more variations became apparent when the printed plate was compared with the original drawing.

²⁶ TCL (note 3). Haid, J. J. to Trew, No. 173, 30 May 1750. Original German: '[Ich kann] nicht jeden Mahler und Illuministen gebrauchen, sondern es müssen Leuthe seyn, die Verstand, Willigkeit, und Gedult haben.'

²⁷ For a study of the professional colouring of engravings by so-called *Briefmaler* in the sixteenth century, complemented by an analysis of their technical manuals, see Dackermann (note 7), 15ff.

²⁸ Theodor M. Fries (ed.), *Johann Beckmanns Schwedische Reise in den Jahren 1765-1766. Tagebuch* (Uppsala, 1911), 147. Original German: 'denen für jede Tafel 4 Stüver bezahlet wird'.

²⁹ Possibly some relative of the Nuremberg engraver J. E. Ridinger, who collaborated with J. W. Weinmann on his *Phytanthoza Iconographia* (note 5).

³⁰ Heidrun Ludwig, *Nürnberger Naturgeschichtliche Malerei im 17. und 18. Jahrhundert* (Marburg, 1998), 188.

³¹ Usually, already the rendering of the engravings themselves depended, among other things, on whether or not the print was to be coloured by hand at a later stage. The instructions given to the engravers were, presumably, quite different: if the print was to remain black and white, a three-dimensional effect could only be achieved through the lines cut into the plate, which, therefore, had to be quite deep and placed closely together. However, if the print was to be painted, as was the case with the illustrations for the *Plantae Selectae*, shading and depth could be attained through tones of colour, which meant that fewer lines were needed and that they could be thinner and less deep; also, cross-hatching for shading was much reduced.



Figure 1: *Lilio-Narcissus*, from an original watercolour drawing by G. D. Ehret (Trew *Plantae Selectae*, Vol. 2, 1751).

The colourists of the plates of the *Plantae Selectae* always worked from Ehret's original illustrations, even when Trew himself only owned copies of them. This was, for example, the case with the *Lilio-Narcissus* (see figure 1): the copperplate was made after a copy that another of Trew's draughtsmen, Nicolaus Friedrich Eisenberger, had drawn; however, for the colouring of this engraving Trew sent Ehret's original drawing to Augsburg, which belonged not to him but to a Nuremberg colleague. This procedure had the advantage that the precious originals remained in the engravers' workshop for as short a time as possible. Only a few pictures came out of the whole engraving process undamaged, which explains why Trew insisted that Haid ask his colourists to treat the image of the *Lilio-Narcissus* more carefully than usual, since he only had it on loan. Trew was used to being disappointed in this respect, and for his own pictures he always expected the worst; however, as Trew stressed in his letters to Haid, he would have to account for the damage done to drawings that belonged to other people, so that at least these pictures should be treated with the utmost care.³² Unfortunately, even this fervent request went unheeded. On 12 December 1750, Trew complained bitterly to Haid that he did not dare to return the *Lilio-Narcissus* to its owner in the sorry state in which it had come back from Augsburg. Instead, Trew commissioned a new painting from Ehret and, in order to prevent this from happening again, pleaded that more care be taken with the originals.³³ Five years later, though, Trew was still making the same complaint, when two other originals were damaged:

[I] have seen with much sorrow that both originals are once again abominably spoiled and therefore I can't refrain from expressing my just complaint to the illuminist. My dear Sir may consider for himself what kind of needless damage is caused to such a valuable collection by this inattentiveness. I can prove that it is possible to spare the originals by giving the example of Mr. Seligmann³⁴ who returned the paintings that I gave him for his flower book as clean and pure as I had given them to him. If your illuminists are not capable of sparing the original, I ask in future that you have somebody else, who is skilful at this, to make a copy and to use this copy, once it has been approved, instead of the original and give it to the illuminists to work from.³⁵

Even as late as 1763 Trew still beseeched his publisher to have the original drawings treated more carefully, but these last pleas were probably heeded no more than the earlier ones.³⁶ With this knowledge, it comes as no surprise to learn that only a few of the original drawings have been preserved: if they were not damaged when the composition was being transferred onto the copperplate or by other accidents in the workshop, then it was surely the colourists who ruined them.

Once a test plate had been coloured, it was sent to Nuremberg for Trew to correct or give the go-ahead for the remaining prints to be coloured in the same way. Ehret's original

³² TCL (note 3), Trew, C. J. to Haid, No. 259, 29 October 1749.

³³ TCL (note 3), Trew, C. J. to Haid, No. 269, 12 December 1750.

³⁴ Johann Michael Seligmann was one of the most renowned publishers of illustrated natural history works, who in 1754 had edited the *Opera Botanica* by Konrad Gesner, with Trew's encouragement.

³⁵ TCL (note 3), Trew, C. J. to Haid, No. 279, 8 December 1755. Original German: '[Ich] habe mit vieler Betrübniß ersehen, dass beyde originalia abermals abscheulich besudelt sind und habe desswegen mich nicht entbinden können, unter einer Probe meine billige Klage dem illuministen verstehen zu geben. Herr HochEdel bedencken selbst, was durch diese Unachtsamkeit für ein Schade einer so schätzbaren Sammlung mit ohne Noth zugefüget wird. Dass es möglich ist, die orig[inale] zu schonen, kann ich mit Hn. Seligmann beweisen, der mir die Mahlereyen, die ich ihm zu seinem Blumen Buch communcire, eben so sauber und rein zuruck gibt wie ich solche ihm einhändige. Wann Ihre Illuministen nicht fähig sind, das original zu schonen, so bitte gar sehr, ins künftige von jemand, der dazu geschickter ist, die Probe Platte verfertigen zu lassen und solche <wenn sie approbiret sind statt des originals> hernach denen illuministen zur Nachahmung zu übergeben.'

³⁶ See TCL (note 3), Trew, C. J. to Haid No. 288, 6 June 1763.

drawings were usually sent with the test plate to enable Trew to compare the original with the printed plate. Haid's regular appeals that the work of his highly stressed colourists be appreciated went unheeded. Trew considered the colouring of the prints to be almost as important as the accurate execution of the engravings, and criticised every single test plate in detail. Occasionally, his remarks were devastating. In January 1751, Trew sent a number of illuminated proofs back to Haid with sarcastic comments, as in the following:

Plate XV: Without even looking at the enclosed original, I knew it would need changes made to it. Held against it [the original], however, nobody would consider this a work of Ehret owing to the faulty illumination: and so, nothing remains to be censured but simply everything. The illuminist must have done this at night, or in his sleep or while drunk, or must suffer from a considerable defect of the eyes. Otherwise he could not have mutilated it more, so that Ehret's delicate hand has been totally spoiled. [...] On the whole I have to say of these sheets that the praise that the engraver finally earned for himself on account of his exceptional industriousness has been totally obscured by the careless illumination. Plates XI and XVIII retain their value. Plates XIII, XIV, XV and XIX are the worst and even the rest need many corrections done to them if they are not to damage Mr. Ehret's reputation.³⁷

Trew's criticisms were not always so harsh, however, and usually he went into more detail. By way of illustration, the following is a list of comments on a batch of proofs that Trew returned to Haid in December 1750:³⁸

Plate XI: The two buds on top more yellow than green, and the remaining three more light yellow than red. The stalk more violet blue.

Plate] XII: The typeface.

[Plate] XIV: The stem to the front or in the light a little paler, as well as the stalk of the flower. The thorns on the stem, where they are in the shade, to be heightened with white. As well as its middle [...?].³⁹ The flesh of the cut fruit whiter and the kernels blacker.

Plate XV: where it says N.N., the flowers could be a little more clearly expressed.

Plate XVI: Add the detail or change the text as follows: *Blattaria flore obsoleto flavescente colore*. H. L. Bat. p. 90.

³⁷ TCL (note 3), Trew, C. J. to Haid, No. 266, 26 January 1750. Original German: 'Tab. XV: ist mir schon ohne das beygelegte original gleich anfangs verdrustig [?] vorgekommen, gegen dieses aber gehalten wird sie der fehlerhaftten illumination wegen von niemandem vor Ehretisch gehalten: dahero auch <davor> nichts als nur alles zu censiren ist. Der Illuminist muß die Probe bey Nachtzeit oder im Schlaf, oder Trunk gemacht haben, oder sonst einen mercklichen Fehler am Gesicht leiden, anderst er dergleichen nicht verstümmelter hätte vorstellen können, indeme hierbey der delicate Ehretische Geschmack gänztlich verdorben worden. [...] Überhaupt aber muß von diesen Blättern sagen, daß das Lob welches sich lezthin der Kupfferstecher durch seinen besondern Fleiß erworben hat durch nachlässiges Illuminiren gänztlich hinwiederum verdunckelt worden. Tab. XI und XVIII behalten hier den Preiß. Tab. XIII, XIV, XV u. XIX sind die schlechtesten und die übrigen alle brauchen noch sehr große Verbeßerungen, wann sie H. Ehret nicht zum Nachtheil gereichen sollen.'

³⁸ TCL (note 3), Trew, C. J. to Haid, No. 269, 12 December 1750. Original German: 'Tab. XI: Die 2 obersten Knöpfe mehr gelb als grün, und die 3 übrigen mehr hell gelb als roth. Den Stengel mehr violet blau. // Tab. XII: Die Schrift. // Tab. XIV: Der Stamm nach vornen zu oder im Licht etwas blasser, wie auch der Stiel der Blume. Die Stacheln am Stamm, wo sie im Schatten kommen mit weis mehr aufgehöh't. wie auch der selben mittlere [...?]. Das Fleisch in der aufgeschnittenen Frucht weisser und die Kerne schwärzer. // Tab. XV: als N.N. stehet könnten die Blumen noch ein wenig deutlicher auseinander gesezet werden. // Tab. XVI: Die Figur bey zusezen oder die Schrift also zu ändern: *Blattaria flore obsoleto flavescente colore*. H. L. Bat. p. 90. // Tab. XVIII: Die 2 gelben Flecken im Blat & oberst bey N.N. mehr licht orange gelb, auch zu unterst am Frucht Stengel die 2 zurück gebogenen blätlein mehr orange oder röther. // Tab. XX: braucht in Ansehung der zweiten Frucht noch eine revision, indemen sowohl g. h. viel zu dunkel und finster, [als] auch das marck zu dieser und der anderen der länge nach aufgeschnittenen Frucht viel zu roth ist.'

³⁹ The original letter is unfortunately stained with ink in places and therefore this word was impossible to decipher.

[Plate] XVIII: The two yellow spots o the leaf & on top at N.N. more light orange yellow, and at the bottom of the fruit's stalk the two small leaves that are bent backwards more orange or red.

[Plate] XX: needs with regard to the second fruit another revision, since g. and h. is far too dark and obscure, and the pith of this and the other fruit, which is cut longitudinally, are far too red.

The endless corrections, additions and Trew's pedantic criticism made Haid's work even more arduous than it already was. In parts, these remarks were justifiable, for example changing a name, requested in the quoted passage for Plate XVI, or the wish to arrange the flowers in Plate XV a little more conspicuously. Fussing over tints between yellow and green or red and orange, though, was going too far. Finally, Haid in his distress asked Trew to send him one of the coloured prints that Ehret had done himself from one of his original drawings, plus the original itself. And from this Haid concluded, with satisfaction, that even Ehret had represented some of the original details differently in the engraving. He commented on this to Trew:

I very much appreciate that I have in my hands the *ceruus*, the original version as well as a print made by Mr. Ehret, and so can see, which is now clear, what I discovered with much research, testing and trying, and which I finally also obediently communicate to Your Excellency. Namely: that it is one thing to colour from nature; it is something else entirely, however, to print and illuminate from another painting. As beautiful as Mr. Ehret's print is, it differs greatly from the original, in the actual colours as well as in its treatment, a fact which Your Excellency refused to accept for my own work, but had been taught the opinion, I don't know by whom and from where, that an illuminated print should and could be totally similar to the original in colours and in treatment, even with respect to the mixed and broken colours, since Nature requires this and nothing else. So, I will repeat once more that I am determined to bring out the *ceruus* as well as I can in print and colouring as Mr. Ehret, but more Your Excellency will not demand, unless it were possible.⁴⁰

Thus, even Ehret did not follow his original drawings exactly when engraving his copperplates and then colouring the resulting prints. This is not too surprising: first, the techniques of watercolour painting and print engraving are very different in terms of their possibilities and limitations; second, a watercolour painting is usually a one-off item, which consequently can be polished and elaborated in far more detail, whereas copper engravings were serially produced and each individual copy had to be hand-coloured. Compromises regarding the quality of every single print therefore had to be made. This might include accentuating single thorns or other parts of a plant with white. Even Ehret had refrained from incorporating this detail when colouring the engravings, as Haid wrote in a later passage of the same letter, so how could Trew ask him, Haid, to do so, since it 'is a business for which a colourist would have to spend almost a whole day only on the hairs or

⁴⁰ TCL (note 3), Haid, J. J. to Trew, No. 164, 15 October 1749. Original German: 'Es ist mir ungemein lieb, dass ich die *Cereus* in original und im abdruck von Herrn Ehret in Handen habe, und sehen kann, welches nun deutlich zeigt, was ich mit vielem Forschen, probiren, und versuchen ersehen, und endlich auch Eur. Excellenz gehorsamst zu erkennen geben habe. nemlich: dass es ein andres seye nach der natur Mahlen, ein anders aber nach einem gemähldrucken und Illuminiren. Denn so schön H. Ehrets abdruck ist, so viel differirt er doch gegen sein original, in der eigentlichen Colleur so wohl, als in der übrigen tractation, womit Eure Excellenz mir es doch nicht haben gelten lassen wollen, auch sich, weis nicht von wem also und woher, die meynung bey bringen lassen, als ob ein illuminirter abdruck dem original in Colleur und tractation völlig ähnlich seyn müsse und könne, auch in vermischten und gebrochenen Farben, es erfordere solches die natur, and. [= anderes] erfordere es nicht. ich sage also nun nochmahls, das ich die *Cereus* so gut in abdruck und illumination bringen wolle, wie Herr Ehret, ein weiteres wird Eure Excellenz nicht fordern, es seye denn, dass es mir möglich werde.'

white thorns, and that with every single print'.⁴¹ Additionally, Haid mentions the advantage of working with fresh material or other sources of information, as opposed to having only a picture, which made the work far more difficult, since one was unable to double-check whether the compromises were apt or not. In short, Trew should take these differences between watercolour paintings and copperplates into account and not be fussier than the actual artist about the colouring of the prints. One cannot say, however, that Haid's pleas were heard -- Trew continued to fuss, the project dragged on even more slowly than before and became an unpleasant burden to everyone involved. Nevertheless, despite all the delays, some issues did manage to be completed – but this is a different story.⁴²

3 The problem of standardisation

3.1 Lack of reproducibility

The most urgent problem of the hand-colouring of eighteenth-century botanical illustrations was the lack of standardised colour recipes and names plus the lack of standardisation in the ways they were used and referred to. The recipes published by Friedrich, which were quoted earlier, were one of many and, in any case, lacked detail. Exactly how much thickening agent was required per quantity of pigment? How much water did one have to add to a pigment? And did changes in either affect the resulting nuance of colour? It is probable that most workshops found their own solutions to these technical problems. Moreover, different names were used for the same pigments and colour mixes.

Eighteenth-century botanists were used to this muddled state of affairs. As was mentioned previously, Linnaeus explicitly excluded colours from the qualities that he considered eligible for characterising species, not just because the colours of plants vary depending on the plants' location but also because it was at that time impossible to reproduce identical colours. Since hardly two draughtsmen used the same colour recipes, the same subject matter could be quite differently coloured in different illustrations. And this uncertainty did not only arise when one compared two illustrations of different origin but also with different copies of the same work: if several colourists were working together, all of them badly trained and under constant pressure to work quickly, two copies of the same work could turn out to be considerably different in their colouring. Trew, for example, criticised Weinmann's *Phytanthoza Iconographia* harshly for the fact that the range of colours in a number of copies of the book was too broad ('for in three copies that I compared, there were considerable differences here and there'⁴³) even though he was well aware of the problems an author faced trying to get a work hand-coloured in good quality.

Furthermore, one could not even be sure that the colouring of a work's illustrations had been carried out following the standards and ideas of the author. As a rule, part of each edition of an illustrated work was sold uncoloured, so that they could be bought more cheaply. In some cases, the buyers of uncoloured plates had their copies hand-painted at a

⁴¹ TCL (note 3), Haid, J. J. to Trew, No. 164, 15 October 1749. Original German: 'eine affaire ist, dar zu ein Mahler bey nahe einen Tag nur mit den Hären oder weissen Stacheln zubringen müste, und das bey jedem abdr[uck].'

⁴² For a more comprehensive reconstruction of the production of eighteenth-century botanical illustrations, see Karin Nickelsen, *Draughtsmen, Botanists and Nature: Constructing Eighteenth-Century Illustrations* (forthcoming), Chapter I.

⁴³ TCL (note 3), Trew, C. J. to Seuter, No. 724, 3 February 1735. Cited T. Schnalke, 1995 (note 3), 115. Original German: 'dann in 3en exemplarien, welche ich miteinander conferiret, hat sich da und dorten ein gar mercklicher unterschied gezeiget.'

later date, under their own instructions. Ehret, for example, was once employed in Regensburg by a banker to colour the more than 800 plates of the latter's personal copy of the twelve-volume *Hortus Malabaricus*, a flora of Indian plants published in the late seventeenth century.⁴⁴ Which criterion Ehret used to carry out this commission is unclear – and just as unclear is whether the result can be considered successful or not, since the copy, unfortunately, is not preserved.

For an impressive example of the diverse character that colouring carried out at a later date could adopt, one has only to examine the preserved copies of the famous *Hortus Eystettensis*: hardly any of the copies resemble each other in their colouring.⁴⁵ As the eighteenth-century French botanist Bernard de Jussieu noted in a brief history of the painting of plants in France, even books on embroidery were used as aids in the hand-colouring of botanical illustrations: 'According to this instruction [in embroidery] presumably a good many set off to colour the books of Brunfels, Matthioli and Fuchs. A wealth of copies are preserved that are very much spoiled, since they followed nature pretty badly.'⁴⁶

3.2 *The colour chart of the Bauer brothers*

Not all draughtsmen readily accepted this unsatisfactory situation, however. Towards the end of the eighteenth century, in an area that was then part of Lower Austria, a small group of people tried to come up with a solution to this problem. The Bauer brothers -- Joseph, Franz and Ferdinand -- grew up in the small town of Feldsberg (since 1920 the town of Valtice in the Czech Republic), where their talent in drawing plants was recognised and promoted when they were still very young; in the 1770s, when they were teenagers, they were involved, to a considerable degree, in helping to produce an extensive and spectacular collection of botanical illustrations.⁴⁷ The two younger brothers Franz and Ferdinand Bauer, in particular, were later held in high repute for their botanical illustrations: Ferdinand was employed as a botanical draughtsman on two important expeditions under British leadership⁴⁸ and Franz worked for Sir Joseph Banks as a botanical draughtsman at London's Kew Gardens. The early works of the three brothers also merit some attention, even though their images cannot, in many cases, be ascribed to a particular brother, since the pictures very much resemble each other. Fortunately, not only

⁴⁴ Henrik A. von Rheede tot Drakenstein, *Hortus Indicus Malabaricus* (Amsterdam, 1678-1703).

⁴⁵ See Nicolas Barker, *The Hortus Eystettensis: the Bishop's Garden and Besler's Magnificent Book* (London, 1994) for a reproduction and comparison of a selection of these plates.

⁴⁶ Bernard de Jussieu, 'Historie dessen, was die Sammlung der Gemähde von Pflanzen und Thieren auf Pergament, die in der königlichen Bibliothek aufbehalten wird, veranlasset und vollkommen gemacht hat', *Der königlichen Akademie der Wissenschaften in Paris Anatomische, Chymische und Botanische Abhandlungen* 7 (1755), 165-172. Cited the eighteenth-century German translation of the original article: 'Nach diesem Unterrichte haben vermutlich so viele unternommen, die Bücher des Brunfels, Matthioli und Fuchs zu illuminieren. Man hat davon noch viele Exemplare, die sehr verunstaltet sind, weil sie der Natur gar schlecht nachgegangen.' (166f.)

⁴⁷ This collection of about 3000 hand-coloured botanical illustrations is known today as the *Codex Liechtenstein*, and was primarily put together by the abbot Norbert Boccus, who encouraged and educated the Bauer brothers: Joseph (1756-1831), Franz (1758-1840) and Ferdinand (1760-1826). On Boccus, the Bauer brothers and the *Codex Liechtenstein*, see Hans W. Lack, *Ein Garten für die Ewigkeit. Der Codex Liechtenstein* (Berne, 1999).

⁴⁸ During 1786-87, Ferdinand Bauer accompanied John Sibthorp on his travels in the Levant, which resulted in the splendid *Flora Graeca*. During 1801-03 he served as botanical draughtsman for Captain Matthew Flinders on the latter's expedition to Australia. The botanist Robert Brown also accompanied Flinders on that voyage, in effect of which he wrote the renowned 'Prodromus florae novae hollandiae'. Brown's influence on Bauer's Australian drawings, which, presumably, was considerable, has not yet been fully appreciated. For a reprint of the botanical Bauer drawings see William T. Stearn (ed.), *The Australian flower paintings of Ferdinand Bauer* (London, 1976).

have many of their completed illustrations survived from this time, so have some of their preparatory sketches executed in pencil. One of these sketches is reproduced in H. Walter Lack's book on the *Codex Liechtenstein* -- a study of two amaryllis flowers.⁴⁹ In addition to making an outline of the plants, the artist has used the technique of hatching to give the picture a three-dimensional effect. One peculiarity of this sketch is the fact that on almost every different organ of the amaryllis plants, and also occasionally on certain sections of organs, numbers have been inserted.

The meaning of these numbers remains mysterious if one looks at the illustration alone. However, Lack uncovered that these numbers were part of a colour code, which the Bauer brothers had begun to use when still based in Feldsberg.⁵⁰ Every number stands for a certain shade of colour that the organ in question should show in the finished illustration; numbers were assigned to the colours by means of a chart on which all the necessary colours were listed in tabular form. Lack tracked down a copy of this colour chart in a Madrid archive, its final destination after a circuitous route round Europe. He suspects that the Bauer brothers drew their sketches from living plants while out on excursions; a particular concern on such trips was, of course, how to make best use of the limited time one had to work on the spot. Lack suggests that the brothers resorted to using a colour chart in order to determine and capture the colours of plants as quickly and as accurately as possible, which they could then later refer to when finishing the coloured plates at leisure. Furthermore, Lack rightly points out that pencil drawings are more water-resistant than watercolours, which could easily be spoiled in a single downpour. If one used a colour chart and pencil sketches, only a single sheet had to be protected against the rain or dampness, and presumably this sheet was carefully looked after.

However, this colour chart may also have served a second purpose. The Bauer brothers did not only work in remote botanical gardens, which would have meant undertaking a considerable journey. Lack himself stresses that the botanical illustrations of the *Codex Liechtenstein* include as many native species as exotic ones, and for the former one did not have to travel to Vienna or Liechtenstein.⁵¹ In addition, the collection also includes copies of plates from other botanical works of the time, for example, copies of the works of Viennese botanist Nikolaus Joseph Jacquin.⁵² The advantage of working quickly but accurately would have been irrelevant in such cases: plants at the wayside can still be observed the next day, while the illustrated books by Jacquin were also presumably at the brothers' disposal in their mentor's library. Enabling a draughtsman to work faster and keep his sketches water-resistant were not the only advantages of using a number code. These colour charts can also be interpreted as the first attempt of a small circle of people to standardise colours and colour recipes. The work of the individual draughtsman is made much easier if he can produce hand-coloured plates in exactly the same colours as the preparatory sketches he drew outside. Spontaneously mixed colours are hard to reproduce but if one has a rich set of standard recipes to which one can constantly refer, reproducing a certain colour becomes problem-free. With the colour chart, the Bauer brothers had a

⁴⁹ See H. W. Lack (note 46); the images were first reproduced in Hans W. Lack, 'Recording colour in late eighteenth-century botanical drawings: Sydney Parkinson, Ferdinand Bauer and Thaddaeus Haenke', *Curtis's Botanical Magazine* 6 (1997), 87-100.

⁵⁰ See H. W. Lack, 1997 (note 48).

⁵¹ For a list of the species represented in the *Codex Liechtenstein*, see H. W. Lack, 1999 (note 46), Appendices 6-8, 319ff. A detailed list of all the species, prepared by Lack himself and still maintained in 2005, is also available at <http://www.bgbm.fu-berlin.de/BGBM/research/data/lack/CodexAnhang7.htm>.

⁵² See H. W. Lack, 1997 (note 48), 91.

system that had all the virtues of an unequivocal system of notation, in which information on colours was fully communicable.⁵³

However, for all the advantages of these colour charts, which were used by only a small number of people, they did not solve the problem of standardisation altogether -- and, indeed, that was not their intention. There is no evidence to suggest that the Bauer brothers tried to make their working process more popular and thereby achieve a standardisation of colour conventions on a greater scale. Other players, however, were more ambitious in their attempts to solve these problems.

3.3 Jacob Christian Schaeffer's 'Farbenverein'

This was the case, for example, in the town of Regensburg in Bavaria, Germany, where the parson and naturalist Jacob Christian Schaeffer (1718 – 1790) had, at around the same time as the Bauer brothers, worked out his own solution to the colouring problem. Schaeffer was a natural history enthusiast, being particularly interested in the taxonomy of fungi, insects and ornithology; he also experimented with electricity and optics, tried to manufacture his own lenses and paper and became famous for having made one of the first washing machines.⁵⁴ Many of Schaeffer's works and treatises are richly illustrated with engravings -- most of them hand-coloured -- so it can be assumed that he knew the difficulties involved in this task.

The booklet that is of particular interest for the purposes of this paper was published by Schaeffer in 1769 with the title 'Plan for a universal relationship of colours; or research and model for determining and naming colours in a way that is useful to the general public'.⁵⁵ Schaeffer described his intentions and motivation in writing this book as follows:

One of the difficulties, which, both in natural history in general and also particularly in the field of insectology, is still prevalent and causes no minor obstacle to the furthering of the latter, is, without any doubt, among other things, the lack of a totally exact and generally understandable determination and naming of colours. [...] Thus, I shall dare to propose how this difficulty and obstacle could possibly be remedied by artistic painters, colourists, etc., maybe not immediately but certainly in time and after repeated attempts. To me the following seems of prime importance: the manifold and considerable differences in the seven main colours have each to be noted down and painted, so that whoever wants to describe an insect or whatever, can find its colour effortlessly in these colour charts and determine it accordingly.⁵⁶

⁵³ On systems of notations and their principle requirements, see Nelson Goodman, *Languages of Art. An Approach to a Theory of Symbols* (Indianapolis, 1969), especially Chapter IV.

⁵⁴ For a detailed description of Schaeffer's life and work, see, e.g. Angelika Reich (ed.), *Jacob Christian Schaeffer. Superintendent, Naturforscher, Erfinder* (Regensburg, 1993), with its lengthy bibliography.

⁵⁵ Jacob Christian Schaeffer, *Entwurf einer allgemeinen Farbenverein; oder Versuch und Muster einer gemeinnützlichen Bestimmung und Benennung der Farben* (Nürnberg, 1769).

⁵⁶ J. C. Schaeffer (note 54), 6f. Original German: 'Zu den Schwierigkeiten, welche wie in der Naturkunde überhaupt, so sonderlich auch in der Insectenlehre, annoch vorwalten, und der ausgebreiteten Förderung derselben keine geringe Hindernis verursachen, gehöret, ohne alle Wiederrede, auch der Mangel einer ganz genauen, und allgemein verständlichen Bestimmung und Benennung der Farben. [...] Ich will es also wagen, und einen Vorschlag thun, wie etwan dieser Schwierigkeit und Hinderniss, wo nicht sogleich, doch mit der Zeit, und nach wiederholten Versuchen, von kunstverständigen Mahlern, Illuministen sc. Könnte und mögte abgeholfen werden. Es kommt, wie mich dünket, die Hauptsache darauf an: Es müssen die so mannigfaltigen und starken Abweichungen der sieben Hauptfarben Jedermann sinnlich in ihrem eigentlichen Aussehen angezeigt und vorgemahlet werden, damit derjenige, so ein Insect oder was es sonst ist, beschreiben will, die Farbe desselben ohne grosse Mühe in solchen Farbenmustern finden, und sie nach demselben bestimmen könne.'

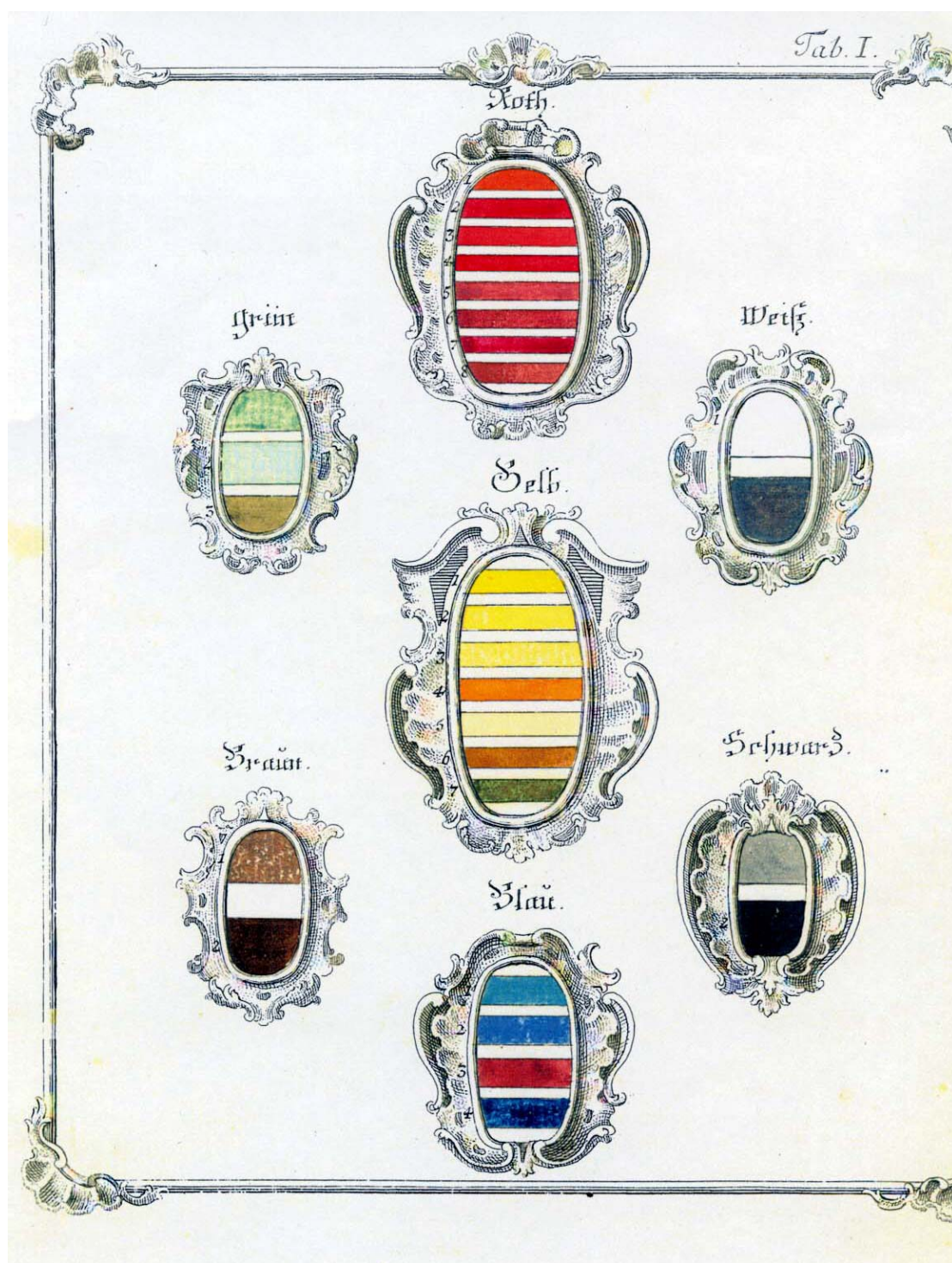


Figure 2: The first plate in Schaeffer's *Plan for a Universal Relationship of Colours*: simple colours. Unfortunately, the colours are no longer in their original condition. (Schaeffer, *Entwurf einer allgemeinen Farbenverein*, 1769).

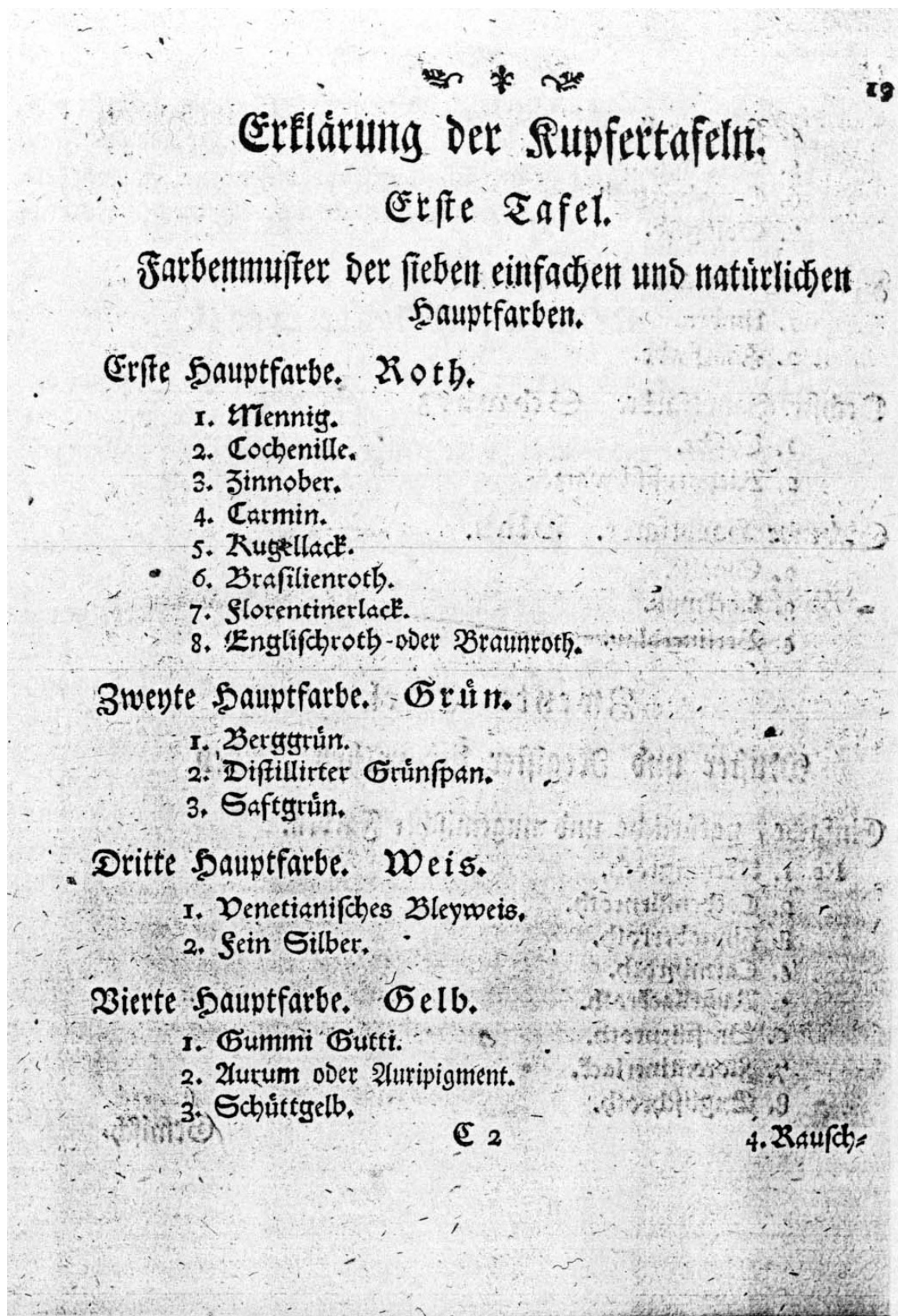


Figure 3: The caption to the plate of simple colours (Schaeffer, *Entwurf einer allgemeinen Farbenverein*, 1769).

In this quotation, Schaeffer describes the problem of colouring not only as a disagreeable nuisance in the practice of publishing but also as a major obstacle in furthering the progress of natural history. According to him, the core of the problem lay in the lack of a systematic taxonomy for determining and naming various colours, the consequence of which was a non-systematic use of colours and their names that did not conform to any standards. In order to solve this problem, Schaeffer suggested that fixed criteria for discerning different colours should be defined, that each defined colour be given an unambiguous name and that this combination of colour and name should be made available to the public by way of samples. Schaeffer, thus, recommended that colour charts be made, sample copies of which he enclosed in his booklet. These charts had to follow a number of rules. First, Schaeffer maintained, one should try to systematise the simple or unmixed colours. For each of the seven main colours -- red, yellow, blue, green, brown, white and black -- a field should be provided on a chart, containing a section or box for the different shades. Then 'one should insert into each such box the simple and natural colour and give it a number or cipher'.⁵⁷ Schaeffer presented one example of this arrangement in an enclosed plate (see figure 2). Simple colours, wrote Schaeffer, were those 'which nature gives herself and from which all [others], and the huge number of composed colours, can be mixed';⁵⁸ that is, simple colours are those colours whose pigments can be found as natural substances and can be applied without adding any further components. In the case of red, these were, according to Schaeffer, the tints *Mennig* (agrimony), *Cochenille* (cochineal) and *Zinnober* (cinnabar) (see figure 3).

Schaeffer suggested that similar charts should be made for composed colours, which are made when two or more simple colours are combined:

Now take a second sheet of paper; divide it into as many smaller boxes as space permits; add a number or cipher to each box; and entitle this sheet with the name of one of the main colours: red, green, yellow, etc.⁵⁹

The corresponding simple or composed colours were then to be applied to the boxes as samples, so that one ended up with a number of charts containing sample patches of colour for all colours available in the three realms of nature. When it came to mixing the colours for the charts, Schaeffer recommended that one should imitate as closely as possible the colours that one found in plants and animals. Only if one needed a colour for which no natural example could be found did Schaeffer acknowledge that:

One has to resort to hand-coloured or illuminated works of entomology or other books of this kind; and prepare the remaining mixed colours that are missing on the colour chart, following these [works] and enter them into their boxes.⁶⁰

Schaeffer thus considered it acceptable to turn to existing natural history illustrations for help in composing a colour chart when the actual objects were unavailable. This supports the interpretation that Schaeffer was primarily interested in standardising and unifying the use of colours, not in a closer imitation of nature: if a useful colour had

⁵⁷ J. C. Schaeffer (note 54), 7. Original German: 'trage [man] in jedes solches Fach, die einfache und natürliche Farbe, und bezeichne sie mit einer Nummer oder Ziffer'.

⁵⁸ J. C. Schaeffer (note 54), 7. Original German: 'welche die Natur selbst giebet, und aus welchen alle anderen, und die ganze grosse Menge zusammengesetzter Farben können gemischt und gebrochen werden'.

⁵⁹ J. C. Schaeffer (note 54), 8. Original German: 'Man nehme also ein zweytes Blatt Papier; theile solches in so viele kleinere Fache ein, als es der Raum leidet; setze jedem Fache eine Nummer oder Ziffer vor; und überschreibe dieses Blatt mit dem Namen einer Hauptfarbe: Roth, Grün, Gelb u.s.w.'

⁶⁰ J. C. Schaeffer (note 54), 10. Original German: '[...] so muss man seine Zuflucht zu ausgemahlten oder illuminirten Insectenwerken, oder andern dergleichen Ausgaben, nehmen; und die auf der Farbentafel noch abgehenden gemischten Farben nach denselben mischen, und in ihrem Fache eintragen'.

already been mixed and established as a suitable shade, it made sense to reproduce it in one's own illustration.

After these colour charts had been constructed, Schaeffer considered it necessary to set up a 'specific and individual colour register', so that 'no confusion arises from the large number of mixed colours and that the manner in which the mixture was made is remembered; and that, in general, the actual aim of these colour charts would be fully achieved'.⁶¹ This colour register should include each number listed in the charts, the natural object -- the animal, plant or mineral -- for which the colour had been mixed (and from which, as a rule, it was named) as well as the colour's recipe. In a caption to his colour charts, Schaeffer provided some examples of how the names should be assigned (see figure 3). Then, the colour charts were to be engraved as copperplates and finally published in a sufficient number of copies, together with all their registers. Thus, Schaeffer's ambitious goal was to establish a generally valid, widely accepted colour reference chart, similar to those that exist today in the various professional fields that use colours in one way or another. By means of set recipes, each colour should be able to be reproduced by anyone at any time and in any place; each numbered pigment (and the name by which it was referred to) was given its own clear definition. The advantages that Schaeffer foresaw from using these charts are described at the end of his booklet:

The first benefit will arise for those naturalists and other scholars or amateurs of natural objects and rarities, who have neither the opportunity, nor could or would they wish to spend the money, to have the objects that they describe drawn, engraved in copper and then hand-coloured. These [people] could express themselves, as I explained before, by quickly and precisely referring to the colour charts, without having to spend painstaking time naming and describing the colours, inventing suitable expressions and, despite all that effort, [the result] remaining ambiguous and incomprehensible.

The second benefit concerns all those who want to learn something about natural objects, and in particular insects, from the description of others; and who want to be convinced whether this or that insect actually and beyond any doubt is the one to which this or that colour is ascribed. This person needs only, as I already mentioned when describing how to use the charts, check the given number and cipher in his colour chart; and his own eyes will teach him if he is accurate or not.

Finally, the third benefit will be of enormous advantage to painters, and particularly colourists, not all of Whom know how to make this or that colour, and frequently waste more than a little time trying to attain the adequate mixture. These people could easily, and with certainty, find what they are looking for, if they looked up the desired colour in the colour charts and consulted the colour registers. This is an advantage that certain painters and colourists will surely not consider as being of minor importance but will recognise [its value] with gratitude.⁶²

⁶¹ J. C. Schaeffer (note 54), 11. Original German: 'ein besonderes und eigenes Farbenregister', so that 'unter der grossen Menge der gemischten Farben keine Unordnung vorgehe, die Art, wie ihre Mischung geschehen, erinnerlich bleibe; und überhaupt der eigentliche Zweck dieser Farbenmuster vollkommen möge erreicht werden.'

⁶² J. C. Schaeffer (note 54), 17f. Original German: 'Der erste Nutzen wird denenjenigen Naturforschern und andern Gelehrten oder sonstigen Liebhabern natürlicher Sachen und Seltenheiten zu statten kommen, welche weder Gelegenheit haben, noch die Kosten aufwenden können und wollen, dasjenige, was sie beschreiben, zugleich mahlen, in Kupfer stechen und illuminiren zu lassen. Diese können bey den Farbenmustern sich angezeigtermassen kurz und deutlich ausdrücken, ohne der Benennung und Umschreibung der Farben mühsam und zeitverderblich nachzusinnen, auf Ausdrücke zu denken, und bey alle dem doch zuletzt noch zweifelhaft und unverständlich zu bleiben. Der zweyte Nutzen betrifft diejenigen, die aus der Beschreibung Anderer die natürlichen Sachen, und sonderlich die Insecten, wollen kennen lernen; und überzeugt seyn mögten, ob dieses und jenes Insect ganz eigentlich und ungezweifelt dasjenige sey, welchem die und die Farbe zugeeignet wird. Ein solcher darf nur, wie schon beym Gebrauche erwähnt worden, die angezeigte Nummer und Ziffer in seinem Farbenmuster nachsehen; so wird ihn der Augenschein lehren, wie er daran ist. Der dritte Nutzen wird endlich Mahlern, und sonderlich Illuministen, ungemein wohl

From Schaeffer's perspective, three different groups of people would benefit from this new system: first, the authors of natural history works, who could dispense with hand-coloured illustrations in their texts. A range of colours -- the names, appearance and recipes of which were fixed in colour charts and registers -- would enable them in future to describe the colours of their objects of study concisely and, even more importantly, unambiguously. The readers of such descriptions form the second group of people to profit from the system, since tints assigned with set names would allow readers to understand to which particular colour a written expression referred. Finally, Schaeffer saw enormous advantages for painters and colourists, who, through the standardisation of different colour recipes, would have the possibility of reliably mixing the correct tint of colour.

Schaeffer, thus, tried to establish a vocabulary of colours by assigning set names to certain colour tints and recipes and create a clear, tabular arrangement of these three related elements. The benefits Schaeffer hoped to gain from this system were considerable. If standardised colour charts had been published and widely distributed, it would have become possible to formulate exact hypotheses on the colour properties of species represented in images. Unfortunately, his system was not widely accepted; various ideological and practical difficulties stood against it. Yet even so, it still offers a notable example of an attempt to make the language of colours as communicable as a written technical language.⁶³

4. Conclusion

A surprising amount of labour and money had to be spent on the hand-colouring of eighteenth-century botanical copper-engravings: this task was so time-consuming that, even with only a moderately large number of copies printed, usually more than one person, more or less talented, was employed to do the job. I have demonstrated some of the many difficulties involved in this practice at the example of a botanical book published by the Nuremberg botanist Jacob Christoph Trew starting from the 1750s in close collaboration with the Augsburg engraver Johann Jacob Haid. Apart from the many practical obstacles, the lack of standardisation of colours was identified as one of the main general problems in using colours in eighteenth-century botanical illustrations. To communicate precise information on the colours of plant species was extremely problematic. At least partly due to this difficulty, colour was taken to be a variable property of species in the Linnean system, and so was denied taxonomic relevance. Nevertheless, illustrations continued to be hand-coloured – at least, until the colour-print technique was more widely available. The problems of evaluating the colouring's quality and achieving some kind of standardisation, however, persisted even then, although an analysis of this question has yet to be written.

zu statten kommen, die nicht gleich wissen, wie diese und jene Farbe herauszubringen, und oft nicht wenig Zeit verderben, bis sie die gehörige Mischung treffen. Diese können, was sie suchen, leicht und sicher finden, wenn sie die verlangte Farbe in den Farbenmustern aufsuchen und das Farbenregister zu Rathe ziehen. Ein Vortheil, den gewisse Mahler und Illuministen gewis nicht klein und geringe ansehen, sondern mit Danke erkennen werden.'

⁶³ Another book dealing with the problem of colour standardisation was written in 1809 by the famous illustrator James Sowerby; see James Sowerby, *A New Elucidation of Colours, Original Prismatic, and Material: Showing their Concordance in the Three Primitives, Yellow, Red, and Blue: and the Means of Producing, Measuring, and Mixing Them: with some Observations on the Accuracy of Sir Isaac Newton* (London, 1809). In this book, Sowerby mainly explains his theoretical approach to colours and how they mix, however, it is highly probable that it was deeply influenced by his practice in dealing with questions of engravings and their illumination.

Acknowledgments

Research on the topics of this paper was made possible through a grant provided by the Swiss National Science Foundation (SNF) from 2000 to 2002 for a project on the history and epistemology of scientific illustrations (Project No. 1152-059499). I am grateful to Professor Dr. Gerd Graßhoff (Berne), who not only headed this project but also provided the funding for the services of a professional copy editor (Margareta Simons, Berne). Furthermore, I am grateful to Professor Dr. Thomas Schnalke (Berlin) for his advice in transcribing some passages of the Trew letters, to Professor Dr. Gerhard Wagenitz (Göttingen) for having pointed out the article by Bernard de Jussieu to me, and to Professor Dr. Hans W. Lack (Berlin), who brought the drawing manual by Johann Christian Friedrich to my knowledge and kindly granted me access to his microfilm copy of this book. Additionally, I would like to thank an anonymous referee for valuable suggestions.

Figure Captions (figures 1 and 2 in colour)

Figure 1: *Lilio-Narcissus*, from an original watercolour drawing by G. D. Ehret (Trew *Plantae Selectae*, Vol. 2, 1751).

Figure 2: The first plate in Schaeffer's *Plan for a Universal Relationship of Colours*: simple colours. Unfortunately, the colours are no longer in their original condition. (Schaeffer, *Entwurf einer allgemeinen Farbenverein*, 1769).

Figure 3: The caption to the plate of simple colours (Schaeffer, *Entwurf einer allgemeinen Farbenverein*, 1769).