

Images of science in the classroom: wallcharts and science education 1850–1920

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One of the educational by-products of German botanical scholarship was the publication of sets of large ‘wall diagrams’ (*Wandtafeln*) for use in the lecture-room. Most British University Departments of Botany dating from the period before the first world war probably had at least one of these sets. In my own department I have used these excellent diagrams occasionally, realizing that they combined clarity, size and accuracy to an unrivalled extent.¹

This passage from a recent essay by S. M. Walters forms an appropriate introduction to the topic of this paper. From the start, it should be noticed that the use of such diagrams (referred to as ‘wallcharts’² in the rest of the paper) was by no means limited to botany nor to university studies. As will become clear, they were one of the most important media for the teaching and learning at different levels of education and within different fields.

It is not difficult to trace historical antecedents for this form of visual communication with educational purposes. In 1658, the Moravian pedagogue Comenius (Jan Amos Komensky, 1592–1670) published his *Orbis sensualium pictus*, a textbook with 150 woodcuts designed to teach pupils how to read by relating words to objects. About one century later, in 1774, the German pedagogue Johann Bernard Basedow (1732–90) enriched his *Elementarwerk* (Elementary school handbook) with a companion atlas reproducing more than 100 copper engravings by the artist Daniel Nicolas Chodowiecki (1762–1801), one of the leading European engravers of the time. According to Basedow, each of these illustrations should be given to the pupil ‘as a gift, each time that appreciation for his

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My interest in scientific wallcharts dates back to the beginning of 1993, when I was invited by Professor Renato G. Mazzolini to examine and catalogue a number of such wallcharts, which are preserved in the Liceo Ginnasio Prati di Trento, Italy. The collection turned out to be very large and interesting, and directed our attention to this particular type of pedagogical communication. I therefore wish to thank Professor Mazzolini for his support throughout the different stages of the research as well as for his comments on an earlier draft of this paper and the State School Liceo G. Prati, Trento, for permission to reproduce items from its collection. For other stimulating comments and suggestions, I am indebted to the editors of this issue. Finally, I would like to express my gratitude to Dr Jutta Schmidt, who carefully provided valuable assistance during my work at the Archiv Schulisches Wandbild of Duisburg University.

1 S. M. Walters, Introduction to D. McAlpine, *Botanical Atlas. A Guide to the Study of Plants*, London, 1989, p. ii.

2 This was the English expression generally used to translate the original German terms for such products, *Wandtafeln* or *Schulwandbildern*.

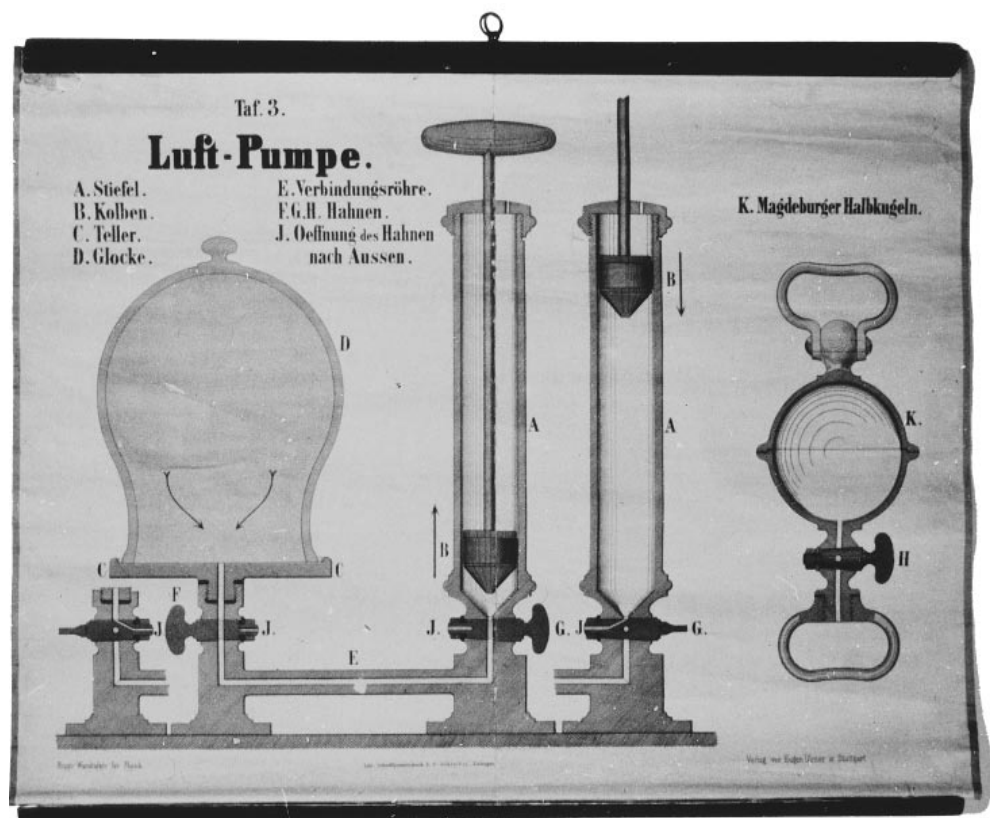


Figure 1. C. Bopp, *Wandtafeln für Physik. Tab. 3: Luft-Pumpe* [Wallcharts for physics. Tab. 3: Air-pump], Stuttgart, 1868. Chromolithography on cloth, 46.5 × 65 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

conduct is to be expressed'.³ He also suggested gluing some of the engravings to a cardboard support, covering them with glass and then hanging them on the walls of the classroom. The subjects depicted included familiar settings (the house, the countryside) as well as arts and crafts, geographic landscapes and natural history subjects. Together with the *Philantropinum* (the school he founded in Dessau in 1764), the *Elementarwerk* was part of Basedow's project to put Rousseau's educational theories into practice. It was very successful all over Europe and was reprinted up to 1909. When asked to give a series of lectures about educational theory in 1776–77, Kant chose to discuss this book and named his lecture series *Pädagogik über Basedows Methodenbuch*. Another important work in

³ 'Ein jedes Blatt muß als ein neues Geschenk an die Kinder, und zwar zu einer solcher Zeit sein, da man ihnen vorzügliche Zufriedenheit mit ihrem Verhalten bezeugen will'. J. B. Basedow, quoted in J. Schmidt, 'Naturgeschichtliche Wandbilder im Wandel didaktischer Theorien', in *Schule halten heißt Welt gestalten* (ed. N. Just and A. Kleckers), Essen, 1990, 65.

this line was the *Bilderbuch für Kinder* (Children's picture book) published by Friedrich Justin Bertuch (1747–1822) between 1790 and 1830 with illustrations portraying not only plants and animals but also exotic items such as Indian fakirs and dragons. The illustrations appeared in no systematic and ordered sequence but they were marked with a number and a reference topic that allowed readers to assemble them and bind them together.

The first wallcharts, that is images explicitly designed to be displayed in the classroom, appeared in the 1820s. They were initially produced in small format (20 × 30 cm), presenting scenes and objects from familiar settings for primary school teaching: pets, kitchen utensils, activities such as hunting, the cycle of the seasons. The young pupils were supposed to learn, with the help of such images, to recognize and name animals, objects and professions. But the 'golden age' for such a genre of didactic communication is to be located between about 1870 and 1920, a period during which several different kinds of wallcharts were produced and sold in large quantities. A wide range of themes was covered, from the historical to the religious, with titles such as 'The creation of the world', 'Greek and Roman war machines' and 'The process of beer production'. Most of the wallcharts were published in series, and they were extensively advertised and regularly reviewed in school magazines such as *Schulwart* (founded in 1903) and *Natur und Schule* (founded in 1902); their purchase was also strongly recommended by school authorities.⁴ Their use gradually spread from primary school teaching to almost any field of study, and they started to be employed at other levels of education also (from middle schools to university). To give just a few figures: in geography alone, more than thirty series appeared between 1880 and 1915; in only five years, there were seven editions of the *Wandtafeln für Physik* by Carl Bopp (1833–1904) following the first edition in 1866 (Figure 1); 2000 copies of the *Zoologische Wandtafeln* by Paul Pfurtscheller (1855–1927) were quickly sold, while the *Schädlingstafeln* (Wallcharts of noxious insects) edited by the entomologist Curt Schlüter (1881–?) were translated into Italian, Polish, Turkish, Arabic, Bulgarian and Russian.⁵ Initially limited to German-speaking countries, wallcharts later became common in other countries such as France and Italy, where the German series were sold (sometimes in a translated version) and where at a later stage original series were also published, such as one edited by the famous French botanist Gaston Bonnier (1853–1922)⁶ and that by the Italian botanist Pietro Voglino (d.1933).⁷ At the turn of the century, wallcharts were no longer confined exclusively to the classroom but were used to address the public on a variety of themes. This can be seen, for instance, in the case of a wallchart prepared in 1904 by the anatomist Anton Weichselbaum (1845–1920, director of the Pathological-Anatomical Institute of the University of Vienna and later rector of the university) for the

4 See for instance the recommendation by the Düsseldorf school authority as reported in Wingolf Lehnemann, 'Schulwandbilder – Bilder für den Unterricht', in *Von Tieren und Pflanzen. Schulwandbilder für die Naturkunde*, Exhibition Catalogue, Münster, 1994, 14.

5 The 'Lehrmittel-Netto Katalog' of 1911 listed more than 6000 different wallcharts. Lehnemann, op. cit. (4), 16. Schlüter did not write or actually design individual wallcharts but conceived of the series and coordinated the work of several other specialists.

6 G. Bonnier, *Tableaux de géologie et paléontologie*, Turin, c. 1905.

7 P. Voglino, G. Roda and V. Bongini, *Organografia vegetale*, Turin, c. 1917.

Österreichischer Verein gegen Trunksucht (the Austrian Association against Alcoholism) (Figure 2). Long series of wallcharts became the chief vehicle for information campaigns about health and hygiene.⁸ Later, the Nazi propaganda machine made extensive use of wallcharts; for instance, they were used to highlight the (supposed) differences between German and Jewish people.⁹

WALLCHARTS AND SCIENCE EDUCATION

With their rich images and colours, wallcharts soon proved to be a particularly suitable medium for the teaching of different classifications in botany and zoology. One of the earliest series circulating was about fungi, *Die essbaren und giftige Schwämme in ihren wichtigsten Formen* (Edible and poisonous fungi in their most important forms) by the illustrator Anton Hartinger (1806–90) and M. A. Becker, first published in 1855 (Figure 3). Another significant series was the *Zoologische Wandtafeln* (Zoological wallcharts), consisting of more than 100 images edited between 1877 and 1892 by the German zoologists Karl Rudolf Leuckart (1822–98) and Heinrich Nitsche (1845–1902) (Figure 4).

Unlike biological specimens and wax models, wallcharts provided a quick and relatively inexpensive means of permitting all the students in a classroom to form an overview of a class of animals or plants and, at the same time, take a closer look at external and internal details. Therefore, it was soon acknowledged that there was a need to provide not just classification schemes but a comprehensive view of an object in its entirety ('Einer ganzheitlichen Gesamtschau').¹⁰ Otto Schmeil (1860–1943), himself a biologist, director of a *Volksschule* (primary school) in Magdeburg, published in 1896 an important essay, which was reprinted eleven times, concerning the need to reform teaching in natural history: *Über die Reformstrebungen auf dem Gebiete des naturgeschichtlichen Unterrichts*.¹¹ He argued that teachers should not fill the heads of their pupils with 'dry descriptions and classifications' but rather 'lead them to a true understanding of nature'. The morphological-systematic approach should be replaced by a biological approach, considering in the first place organisms as living bodies¹² and accounting for the strong causal relationship existing between their structure and their way of living. In a chapter entitled 'On observation' he reported the results of an interesting survey he had conducted among 150 pupils from his school, aged 12 to 14, by asking them questions like 'Have you ever seen a beehive?' or 'Have you ever seen mushrooms in a wood?'. From the number of negative answers recorded, he concluded that the teaching of biology was lacking the equivalent of laboratory experiments in physics or chemistry, that is, a real, live encounter with its objects. He wrote

8 J. Schmidt, *So Bleibt man gesund! Gesundheitserziehung in visuellen Medien von 1900 bis 1950*, Essen, 1995.

9 W. Müller, *Anschauung und Ideologie. Schulwandbilder der NS-Zeit aus Duisburg*, Duisburg, 1983.

10 Schmidt, op. cit. (3), 69.

11 O. Schmeil, *Über die Reformstrebungen auf dem Gebiete des naturgeschichtlichen Unterrichts*, Stuttgart, 1896.

12 A. Seybold, 'Otto Schmeils Lebenswerk', in *Otto Schmeil: Leben und Werk eines Biologen – Lebenserinnerungen*, 2nd edn, Heidelberg, 1986.

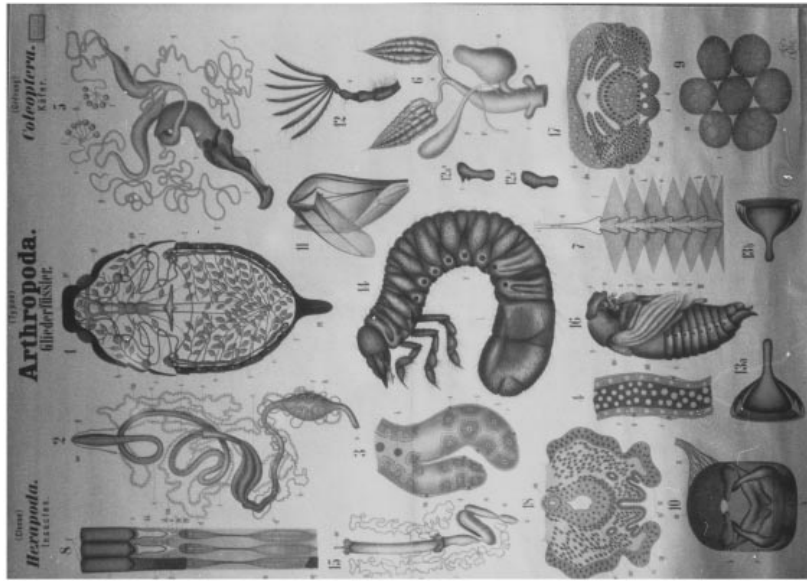


Figure 4. K. Leuckart and H. Nitsche, *Zoologische Wandtafeln*. Tab. 84: *Arthropoda*–*Hexapoda*–*Coleoptera* [Zoological wallcharts. Tab. 84: *Arthropoda*–*Hexapoda*–*Coleoptera*], Cassel, 1877–92. Chromolithography on cloth, 133 × 102 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

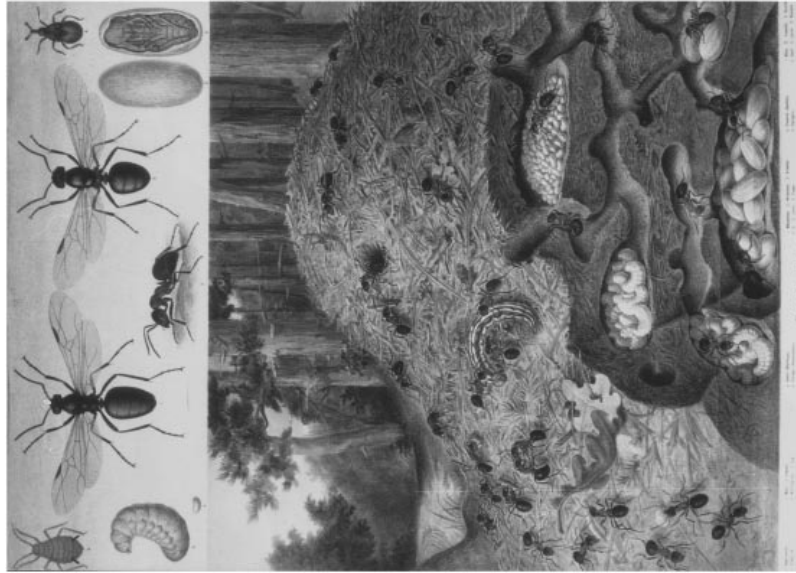


Figure 5. A. Lehmann, *Zooologischer Atlas*. Tab. 47: *Ameise mit Bau* [Zoological atlas. Tab. 47: *Ants with their anthill*], Leipzig, 1895. Chromolithography on cloth, 83 × 64.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.



Figure 6. A. Lehmann, *Zoologischer Atlas. Tab. 54: Kolibri* [Zoological Atlas. Tab. 54: Hummingbird], Leipzig, 1895. Chromolithography on cloth, 63 × 85.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

Nothing is in the understanding that has not before been in the senses!...Only through diligent observation, personal viewing and personal investigation, is it possible to banish the worst enemy of any formative teaching: verbalism.¹³

Schmeil and other teachers of his time were strongly influenced in this by the work of biologists such as Karl August Möbius (1825–1908), founder of the first German sea aquarium in Hamburg (1863) and later director of the Zoological Museum of Berlin University. From 1870 on, Möbius had been delivering lectures for school teachers in Kiel in which he emphasized the importance of considering animals and plants as part of a ‘living community’ (*Lebensgemeinschaft*) rather than isolated objects.¹⁴

13 ‘Nichts ist im Verstande, was nicht zuvor in den Sinnen war!...Nur durch fleißiges Beobachten, durch Selbstschauen und Selbstuntersuchen ist es möglich, den schlimmsten Feind alles geistbildenden Unterrichts aus der Schule zu verbannen: den Verbalismus’. O. Schmeil, in Seybold, op. cit. (12), 243.

14 Friedrich Junge, a teacher from Kiel, had a key role in translating Möbius’s principles into pedagogical practice. F. Junge, *Der Dorfteich als Lebensgemeinschaft*, 3rd edn, emended and expanded edition, Kiel, 1917.

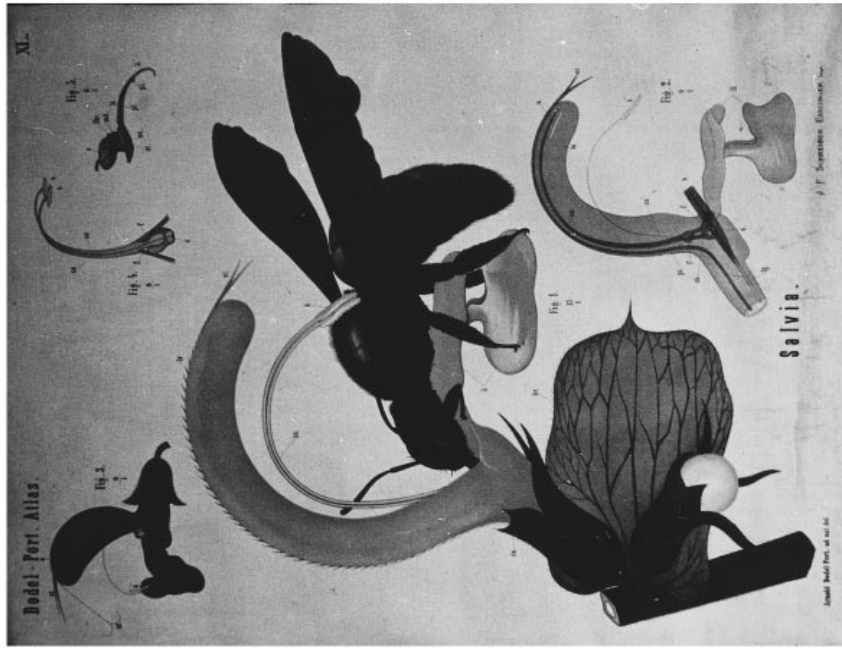


Figure 8. A. and C. Dodel-Port, *Anatomisch-physiologischen Atlas der Botanik*. Tab. 40: *Salvia*, [Anatomical-physiological atlas of botany. Tab. 40: Sage], Esslingen, 1878–83. Chromolithography on cloth, 82 × 64 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

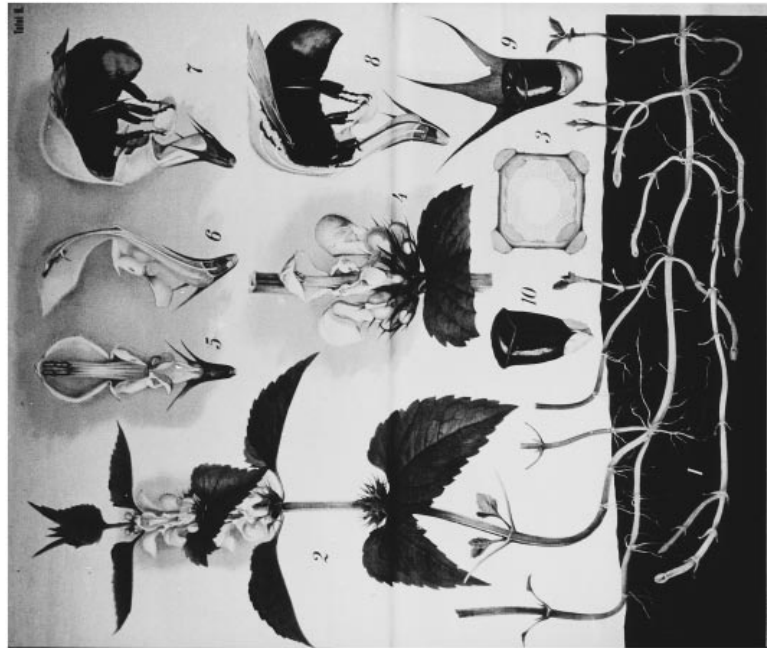


Figure 7. O. Schmeil, *Botanische Wandtafeln*. Tab. 2: Weisse Taubnessel [Botanical Wallcharts. Tab. 2: White Nettle], Stuttgart, 1903. Chromolithography on cloth, 133 × 115 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

All living plants and animals that the child sees belong to living communities, either natural or shaped by human action... Gardens, meadows, field and woods offer plenty of opportunities for teaching pupils – whatever their age – that all living beings are members of living communities. The child feels he himself belongs to a living community that includes his parents, his siblings, his playmates, servants and pets.¹⁵

Series of wallcharts such as Adolf Lehmann's *Zoologischer Atlas* clearly demonstrate how these ideas were reflected in the production of educational materials (Figures 5 and 6). In his book about the teaching of biology, to which I have already referred, Schmeil himself praised the use of illustrations of living communities (*Lebensgemeinschaften*) in inducing the pupils to see that 'nature should be understood not as a conglomerate, but as an organism'.¹⁶ These principles were to be applied by Schmeil in his own series of wallcharts, the *Botanische Wandtafeln* (Botanical wallcharts). For instance, in the wallchart shown in Figure 7, the plant is not just displayed in its different parts; one of its most important living functions, reproduction, is presented in a separate figure. This form of representation can be observed in many other images of plants, like the one in Figure 8 which is from the *Anatomisch-physiologischen Atlas der Botanik* (Anatomical-physiological atlas of botany) written by the Swiss botanist Arnold Dodel-Port (1843–1908, professor at the University of Zürich) with the help of his sister Carolina.

Thus wallcharts were expected to provide not only descriptions, but also an explanation of processes and, in some cases, even prescriptions of the conduct to be adopted in regard to certain natural phenomena, as in the wallcharts of the *Schädlingstafeln* series (Figure 9). The caption contained information about the life and behaviour of each parasite, as well as practical suggestions on how to combat it. This impulse directed to a more 'lively' presentation of biological subjects corresponded perfectly with the two main, and often overlapping, strategies used in wallcharts to facilitate the pupil's encounter with plants and animals. One consisted in presenting the object not as such, but in its natural environment (see Figures 10 and 11). The use of this form of presentation was one of the cardinal rules of *Anschaunungsunterricht*, teaching through images: to proceed from the known (familiar animals and plants) to the unknown (more exotic subjects). The other strategy was based on the aesthetic appeal of images. In reviewing the *Zoologische Wandtafeln* edited and drawn by Paul Pfurtscheller (a high-school teacher – *Gymnasial Lehrer* – from Austria), Schmeil wrote: 'In my opinion, they are the most artistically accomplished wallcharts that have appeared so far.'¹⁷ Other reviewers made similar comments:

15 'Alle lebenden Pflanzen und Tiere, die das Kind sieht, gehören natürlich oder durch den Menschen veränderten künstlichen Lebensgemeinschaften an...Gärten, Wiesen, Felder und Wälder bieten reichliche Gelegenheit dar, Schüler aller Alterstufen zu belehren, daß alle lebenden Wesen bedingte und mitbedingende Glieder von Lebensgemeinschaften sind. Das Kind fühlt sich selbst als Glied einer Lebensgemeinschaft mit seinem Eltern, Geschwistern und Gespielen, mit dem Hausgesinde und den Haustieren.' K. A. Möbius, quoted in J. Schmidt, 'Die "biologischen" Wandbilder von Otto Schmeil', *Die weite Welt im Klassenzimmer. Schulwandbilder zwischen 1880 und 1980*, Exhibition Catalogue, Cologne, 1984, 81.

16 'Die Natur nicht als ein Konglomerat, sondern als ein Organismus erfaßt werde' quoted in Widar Lehnemann, 'Einheimische Wildtiere auf Schulwandbildern', in *Von Tieren und Pflanzen. Schulwandbilder für die Naturkunde*, Münster, 1994, 72.

17 'Dabei sind die Bilder künstlerisch in einer Weise vollendet, wie dies m. A. nach in keinem Tafelwerk bisher erreicht worden ist.' O. Schmeil, 'Review of Paul Pfurtscheller's *Zoologische Wandtafeln*', *Natur und Schule* (1903), 2, 308.

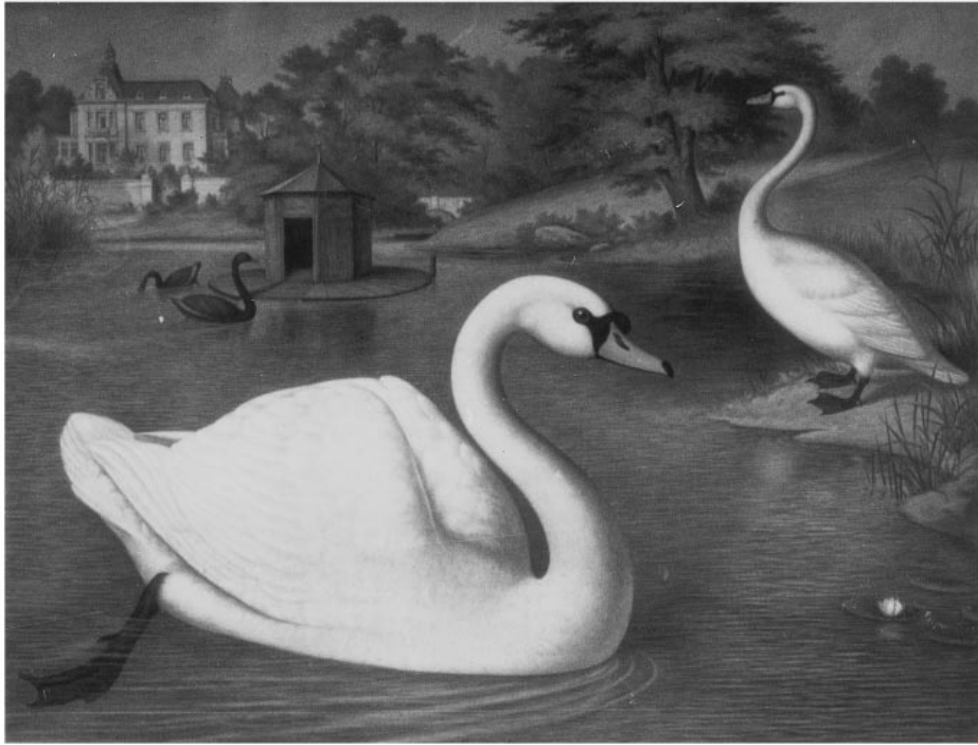


Figure 10. A. Lehmann, *Zoologischer Atlas*. Tab. 45: *Schwan* [Zoological atlas. Tab. 45: Swan], Leipzig, 1895. Chromolithography on cloth, 63 × 85.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

These images, being ‘art works for the wall’ [*künstlerischer Wandschmuck*] in the school, will accordingly also exercise a favourable aesthetic influence upon pupils.¹⁸

[These wallcharts] are moreover different from those by Leuckart in giving greater importance to the formal elements in the image [*Habitusbild*], and at the same time try to display the internal organisation of the structure, while Leuckart’s wallcharts neglect such formal elements.¹⁹

Living nature is the best teacher and pedagogue; an artistic medium of representation [*Anschaungsmittel*] tries to replace nature and this can be possible in practice only if the images are true to natural objects.²⁰

18 ‘Diese Bilder werden daher auch als “künstlerischer Wandschmuck” eigener Art in Schulen aufs vorteilhafteste ästhetisch auf die Jugend einwirken.’ K. Fuss, ‘Urteile über Professor Dr. Paul Pfurtschellers Zoologische Wandtafeln’, in A. Pichlers Witwe und Sohn Katalog, *Buchhandlung und Lehrmittel-Anstalt*, Leipzig, 1903, 5.

19 ‘Sie unterscheiden sich von den Leuckartschen Tafeln allerdings dadurch, daß sie mehr Wert auf das Habitusbild legen, zugleich aber auch am habitusbilde selbst die innere Organisation zu zeigen suchen, während die Leuckartschen tafeln das Habitusbild vernachlässigen.’ F. Fedde, ‘Urteile über Professor Dr. Paul Pfurtschellers Zoologische Wandtafeln’, in Pichlers, op. cit. (18), 5.

20 ‘Ist die lebendige Natur die beste Lehrerin und Erziehrin; ein künstliches Anschauungsmittel will aber die Natur ersetzen und das ist nur dann in zweckdienlicher Weise möglich, wenn die Bilder von Naturgegenständen wahr sind’. A. and C. Dodel-Port, *Erläutender Text zum Anatomisch-physiologischen Atlas der Botanik*, Esslingen, 1883, p. ii.



Figure 11. A. Lehmann, *Zoologischer Atlas*. Tab. 53: *Kohlweissling* [Zoological atlas Tab. 53: Cabbage butterfly], Leipzig, 1898. Chromolithography, 62 × 85 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

It is, moreover, also a matter of interest that illustrators like Heinrich Leutemann (1824–1905) came to draw scientific wallcharts after a long experience in drawing animals for children’s books of tales and fables. Gottlieb von Koch (1849–1914), who participated in the production of Jung’s *Neuen Wandtafeln für den Unterricht in der Naturgeschichte* (New wallcharts for teaching natural history), was a painter with a strong background in biology; he had also been an assistant of Ernst Haeckel (1834–1919) in Jena and was later appointed professor of zoology at a *Hochschule* in Darmstadt. (See Figures 12 and 13).²¹ Given the importance of their contribution to the design of wallcharts, illustrators were often the most well known and well paid among those involved in the production of such series (such as authors of texts, editors). Leutemann, for instance, one of the biggest celebrities of the wallchart market, did not simply execute the drawings for the *Zoologischer Atlas* (Zoological atlas) edited by Carl Adolph Lehmann (1842–1927) but was actually able to negotiate and shape its content;²² Hartinger was generally regarded

21 U. Thieme and F. Becker, *Allgemeines Lexikon der bildenden Künstler von der Antike bis zu Gegenwart*, 6 vols., Leipzig, 1972, xxi, 74.

22 A. Bertram, ‘Heinrich Leutemann als Illustrator von Schulwandbildern. Dargestellt am “Zoologischen Atlas”’, thesis, University of Duisburg, 1985.



Figure 12. P. Pfurtscheller, *Zoologische Wandtafeln. Tab. 19: Aves I (Situs viscerum) Columba Dom* [Zoological wallcharts. Tab. 19: Birds I (intestine) domesticated dove], Vienna, 1907. Chromolithography, 137 × 126.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

as the author of the series he illustrated (*Hartinger's Wandtafeln*), despite the involvement of other contributors in terms of texts and scientific supervision. The dominant role played by illustrators is confirmed by the fact that in several cases (as for the first editions of Hartinger's *Schwämme* series and for the first editions of Pfurtscheller's *Zoologische Wandtafeln*), the illustrators showed a lively entrepreneurial spirit by themselves acting as publishers of the series.

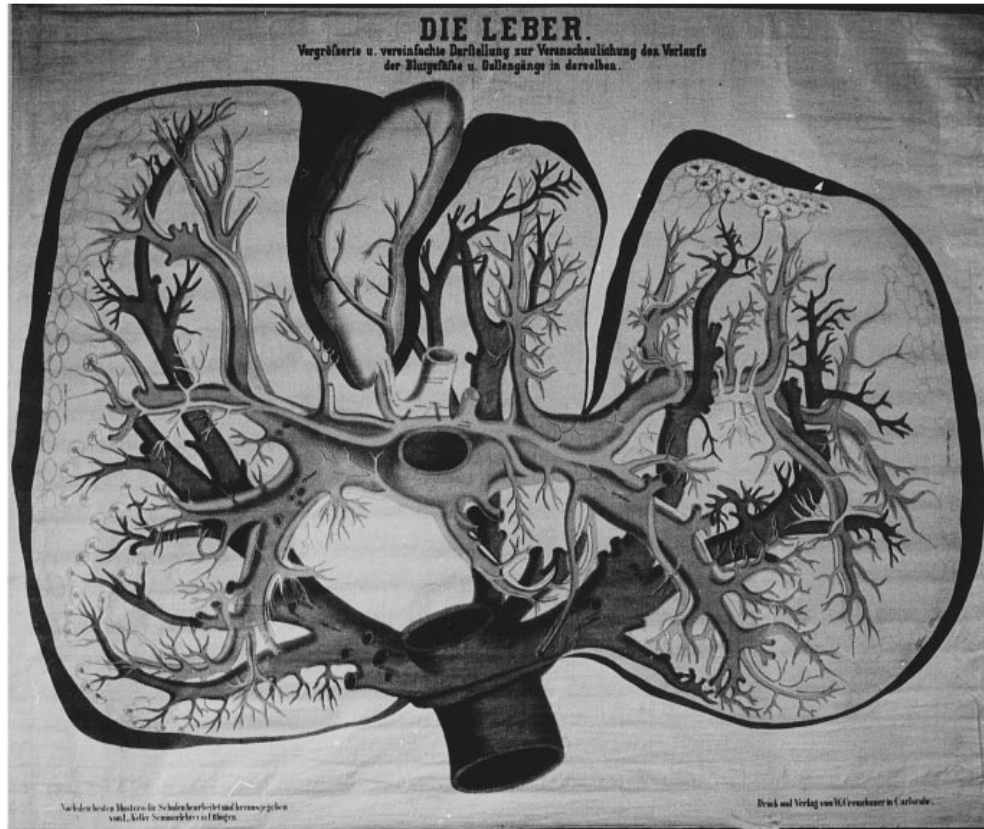


Figure 13. L. Keller and R. Zilles, *Anatomische Schulwandtafeln. Tab. 4: Die Leber. Vergrößerte u. vereinfachte zur Veranschaulichung des Verlaufs der Blutgefäße u. Gallengänge in derselben* [Anatomical wallcharts. Tab. 4: The liver. Enlarged and simplified to display the vessels for the circulation of blood and of bile in the same figure], Karlsruhe, 1883. Chromolithography, 66.5 × 79.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

THE ORIGIN AND SUCCESS OF WALLCHARTS

Why did this particular medium for the visual communication of science enjoy such great diffusion and popularity? I will here suggest three main sets of reasons.

(a) *Technical reasons.* Wallchart diffusion was clearly related to important advances in printing technology. The invention of lithography in 1798 by Aloys Senefelder (1771–1834), which in Germany was developed on an industrial scale by the Englemann workshops from 1816 on, laid the basis for the production of large colour prints at a reasonably low price.

(b) *Educational reforms.* Processes of reform had taken place in the organization of education in the German states. To quote the historian of education Karl Ernst Jeismann, ‘In the nineteenth century the State put into effect, what it had announced in the eighteenth century and it became a school state. After the military and the tax state, the school state



Figure 14. H. Jung, G. Von Koch and F. Quentell, *Neuen Wandtafeln für den Unterricht in der Naturgeschichte. Botanik. Tab. 14: Weisse Taubnessel* [New wallcharts for teaching natural history and botany. Tab. 14: White nettle], Darmstadt, 1894. Chromolithography, 70 × 98.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

came into being with the state educational system.²³ As a result, the number of school children grew enormously, especially in primary school. In the 1840s, there was a 40 per cent increase in the number of teachers, while the number of school-children increased by 108 per cent in the same period. The average teacher had 103 pupils in 1833 and 136 pupils in 1852.²⁴ It became increasingly difficult to show images by simply circulating picture books or small engravings. There were similar difficulties in permitting every student to have a good view of a biological specimen or a chemical experiment. As the Dodel-Ports noted: 'There are many objects which it is impossible to show through the microscope when teaching in a classroom.'²⁵ It was soon recognized that these difficulties could be

23 'Im 19. Jahrhundert verwirklichte der Staat, was er in 18. Jahrhundert angekündet hatte: er wurde zum Schulherrn. Nach dem Militär- und dem Steuerstaat entstand mit dem "staatlichen Unterrichtswesen" (Lorenz von Stein) der Schulstaat.' K. E. Jeismann, 'Zur Bedeutung der Bildung in 19. Jahrhundert', in *Handbuch der deutschen Bildungsgeschichte*, 3 vols., Munich, 1987, iii, 4.

24 K. A. Schleunes, *Schooling and Society: The Politics of Education in Prussia and Bavaria, 1750–1900*, Oxford, 1989, 113. See also A. Leschinsky and P. M. Roederer, *Schule im historischen Prozess*, Stuttgart, 1976, 122 ff.

25 'Das vorweisen und demonstrieren von zahlreichen Objekten am Microscop selbst ist für den Klassenunterricht eine Unmöglichkeit'. A. and C. Dodel-Port, op. cit. (20), p. ii.



Figure 15. E. Fraas, *Die Entwicklung der Erde und ihrer Bewohner. Tab. 2: Jüngere Paläozoische Formationen* [The development of earth and its inhabitants. Tab. 2: Late Palaeozoic formations], Stuttgart, 1906. Chromolithography on paper, 80 × 163 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

overcome by using large wall-images that could be seen reasonably well from every part of the classroom.

In 1866, in the text accompanying his *Wandtafeln für Physik*, Bopp cautioned:

In order not to increase production costs too much, a format has been chosen for the wallcharts which should fit the majority of needs; however, should an even larger format become necessary for extraordinarily large schools, it would not be very difficult to enlarge one image or another by some graphical technique.²⁶

Presenting his series of botanical wallcharts, Heinrich Jung explained ‘These images are so executed as to allow them all to be recognized from any seat in the classroom.’²⁷ Paul

26 'Sollte für ausnahmsweise große Schulen ein noch größeres Format nöthig sein, so ist es nicht sehr schwer, sich die eine oder andere Tafel durch einen des Zeichnen Kundigen in der nöthigen Vergrößerung nachbilden zu lassen.' C. Bopp, *Text zu den acht Wandtafeln für Physik*, Ravensburg, 1866, p. v. At this time a variety of apparatus was available to assist in copying drawings in different sizes.

27 'Die Abbildungen sind so auszuführen, daß jede einzelne deutlich von allen Plätzen einer Klasse erkannt wird'. H. Jung, *Begleittheft zu den Neuen Wandtafeln (Zoologie und Botanik) für den Unterricht in der Naturgeschichte*, Darmstadt, 1894, p. iii.

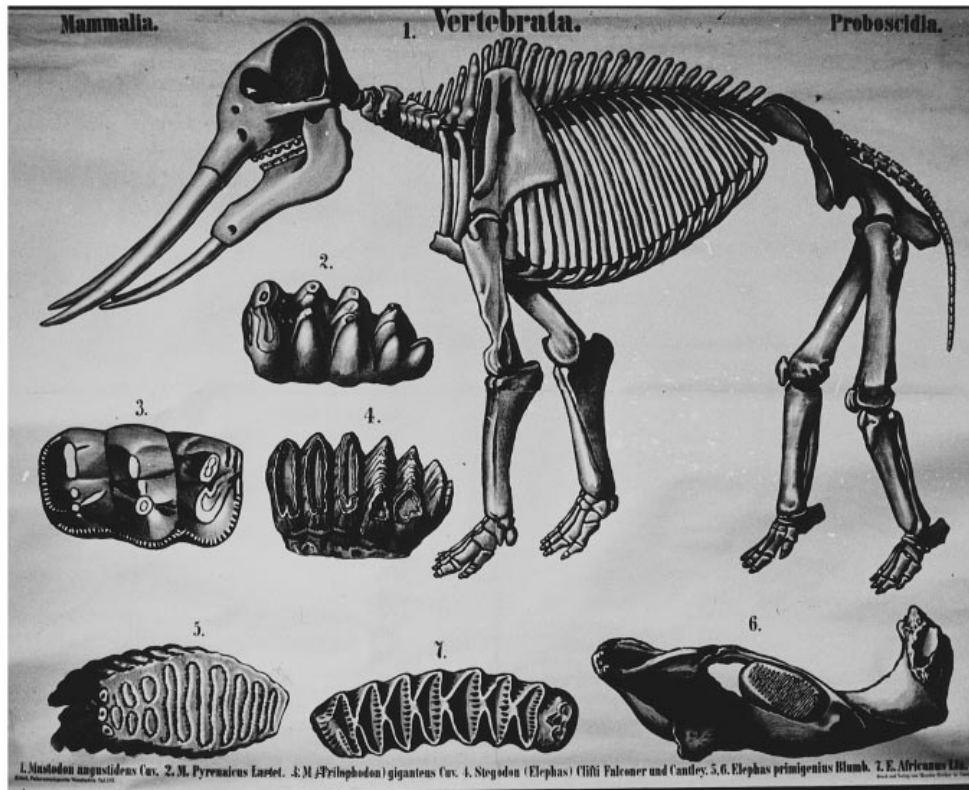


Figure 16. K. A. von Zittel and K. Haushofer, *Paleontologische Wandtafeln und Geologische Landschaften*. Tab. 57: Vertebrata–Mammalia–Proboscidea [Palaeontological wallcharts and geological landscapes. Tab. 57: Vertebrata–Mammalia–Proboscidea], Cassel, 1879–1901. Chromolithography on cloth, 108 × 143.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

Wossidlo made a similar remark about Pfurtscheller's zoological wallcharts: 'The format has been chosen to be large enough to enable the details of illustrations to be visible even in very crowded classrooms.'²⁸

(c) *The role of visualization.* Visualization was assigned a fundamental role by the educational thought of the time. Reformers of the educational system such as Karl Wilhelm von Humboldt (1767–1835) were heavily influenced in their practice by the ideas of Heinrich Pestalozzi (1766–1827). Central to Pestalozzi's pedagogical theory was the idea that children learn by transforming their own original 'vague sense impressions' into 'distinct and definite ideas'. As Pestalozzi put it in *Wie Gertrud ihre Kinder lehrt* (How Gertrud teaches her children, 1801), 'the world lies before our eyes like a sea of confused sense impressions, flowing into one another'.²⁹ In order to achieve this transformation

²⁸ 'Der Maßstab ist so groß gewählt, daß auch in stark besetzten Klassen die Details der Abbildungen zur Anschauung kommen'. P. Wossidlo, 'Urteile über Professor Dr. Paul Pfurtschellers Zoologische Wandtafeln', in Pichlers, op. cit. (18), 5.

²⁹ Quoted in W. Boyd, *History of Western Education*, London, 1921 (6th edn, 1954), 323.



Figure 17. G. Bonnier, *Tableaux de Géologie et Paléontologie*. Tab. 3: *Végétaux de l'Epoque primaire* [Geology and palaeontology wallcharts. Tab. 3: Plants from the Primary era], Turin, c. 1905. Lithography on cloth, black and white, 113 × 92.5 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

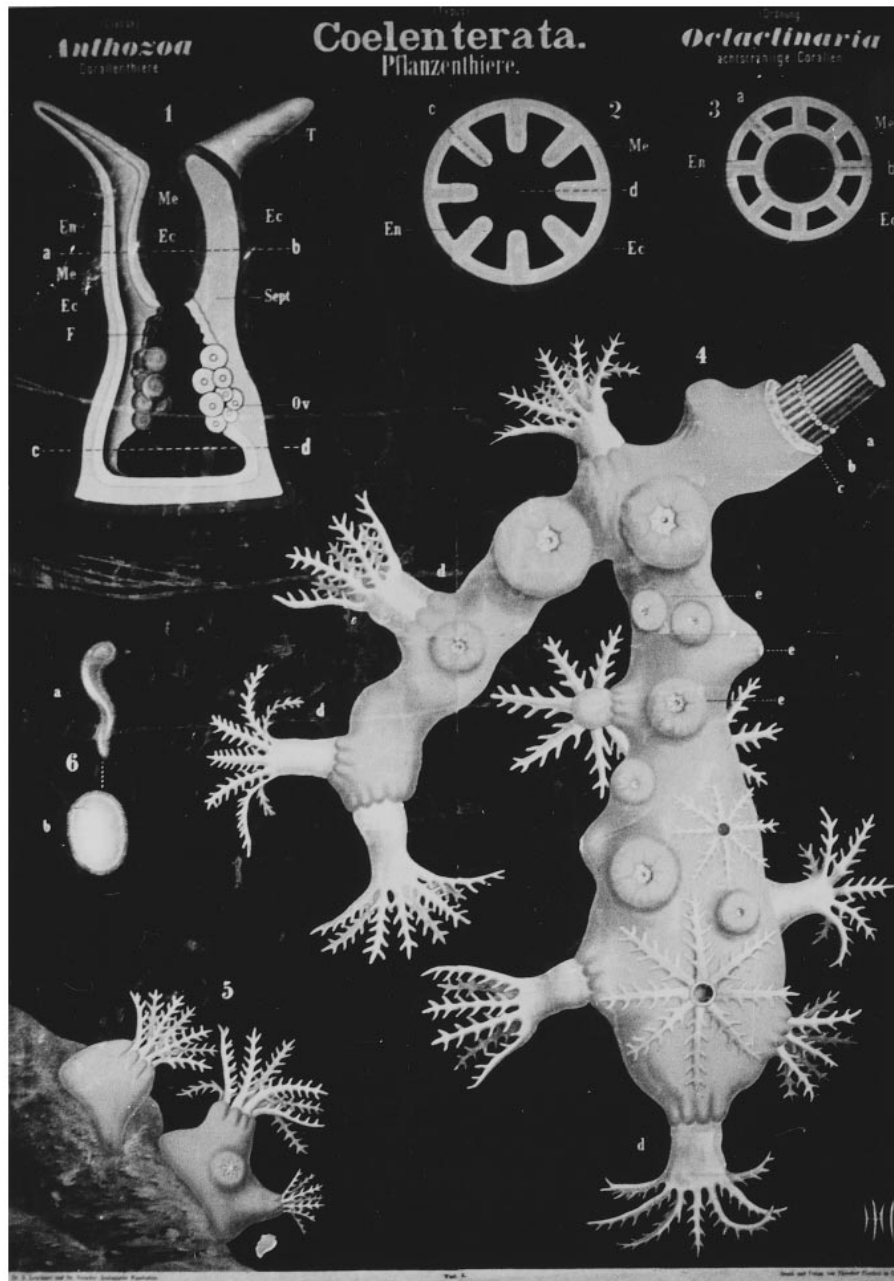


Figure 18. K. Leuckart and H. Nitsche, *Zoologische Wandtafeln. Coelenterata (Pflanzenthier) – Anthozoa (Corallenthier) – Octactinaria (achtstrahlige Korallen)* [Zoological wallcharts. Coelenterata (plants) – Anthozoa (corals) – Octactinaria (eight-rayed corals)], Cassel, 1877–92. Chromolithography on cloth, 133 × 102 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

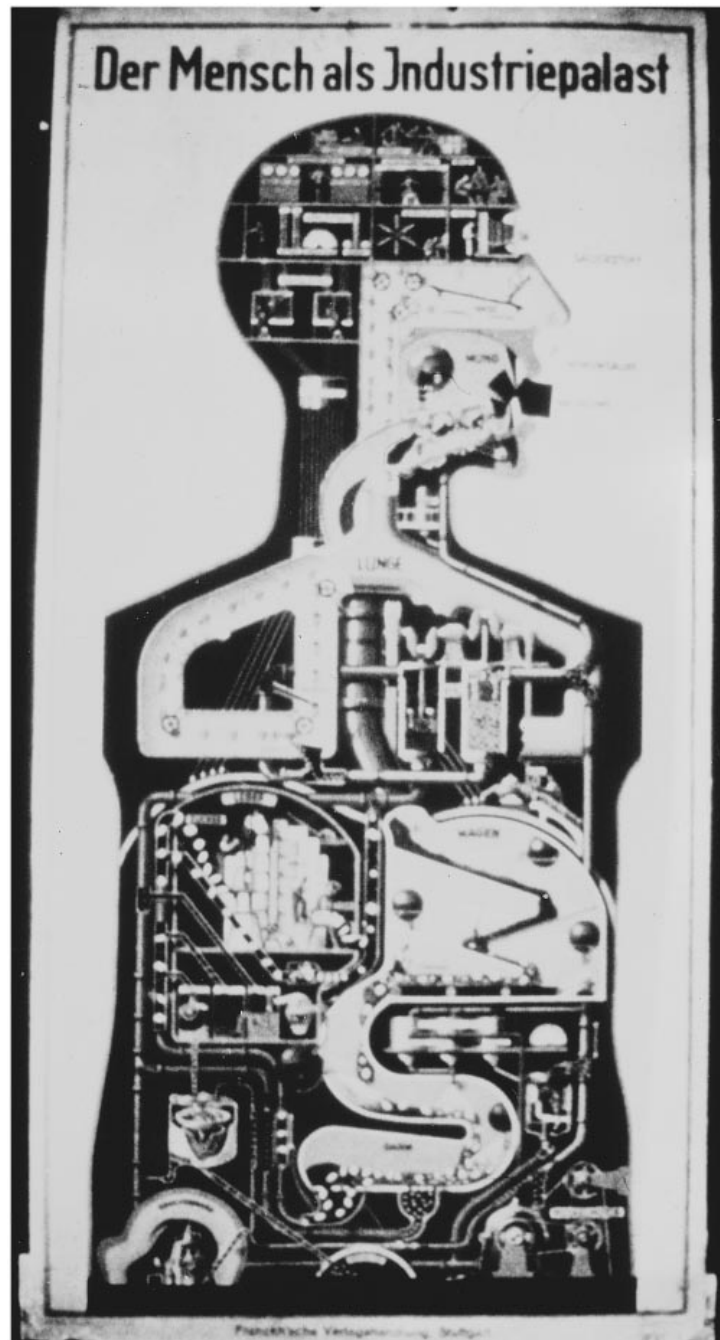


Figure 19. A. von Kahn, *Der Mensch als Industriepalast* [Man as a factory], Stuttgart, c. 1920. Chromolithography on paper, 95 × 80 cm, Collection of the Archiv Schulisches Wandbild, Duisburg, Germany.

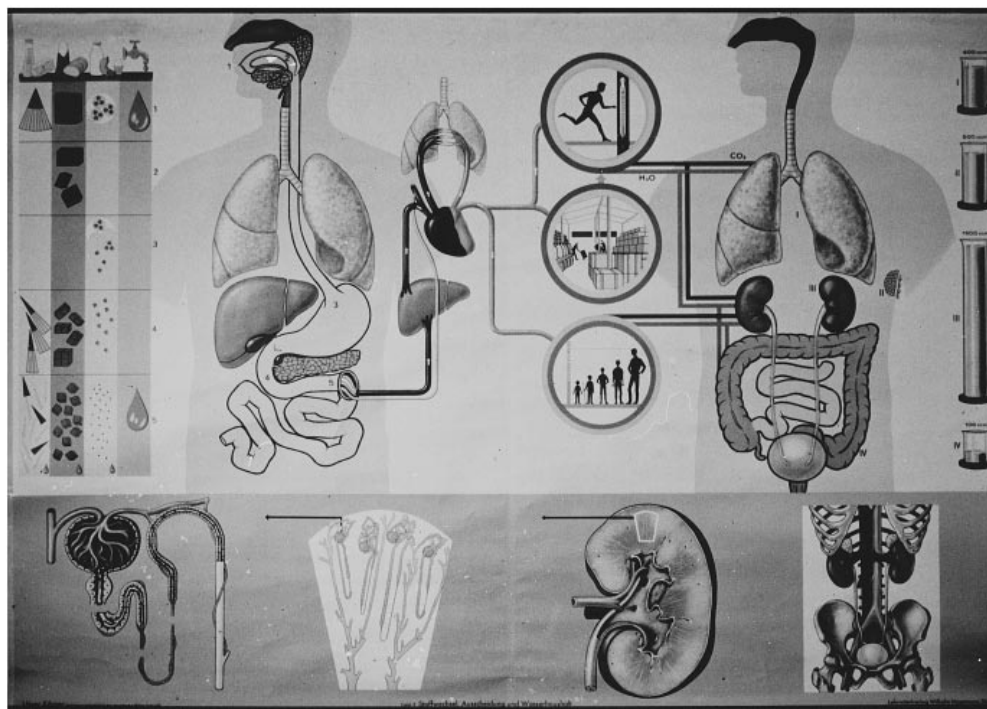


Figure 20. K. Rosenbauer and F. von Hagen, *Unser Körper, Lehrtafeln für menschenkundlichen Unterricht*. Tab. 9: *Stoffwechsel, Ausscheidung und Wasserhaushalt* [Our body. Wallcharts for the teaching of human anatomy and physiology. Tab. 9: Metabolism, secretion and balance of fluids], Düsseldorf, 1963. Chromolithography on cloth, 117 × 165 cm, Collection of the State School Liceo G. Prati, Trento, Italy.

process, Pestalozzi considered it crucial that pupils be provided with what he called 'Anschauung'. 'Anschauung', that is 'Intuition', in the Kantian sense, given by sense data within the transcendental forms of space and time, implied that the pupil should become directly acquainted with an object by seeing it or handling it instead of merely hearing about it. Soon an *Anschauungsunterricht* was developed, designed for young pupils to learn to recognize animals or environments and their names. But *Anschauung* was most of all a method that, as we have seen, could be applied to any kind of teaching, including that of scientific topics. This was recognized by the same researchers, whose commitment to extend and reform the teaching of biology culminated in 1901 in the so-called 'Hamburger Theses', which declared biology to be 'an empirical science [*Erfahrungswissenschaft*]... with no interest in metaphysical speculation', and capable of teaching 'the so often neglected art of observing solid reality'.³⁰ A few years later, the Education

³⁰ '1. Die Biologie ist eine Erfahrungswissenschaft,...Für metaphysische Spekulationen hat die Biologie als solche keine Verantworen...2....Im besondern lehrt die Biologie die sonst so vernachlässigte Kunst des Beobachtens an konkreten.' A. Gutzmer, 'Reformvorschläge für den mathematischen und naturwissenschaftlichen Unterricht', *Zeitschrift für mathematische und naturwissenschaftlichen Unterricht* (1905), 36, 533ff.

Commission of the German Society of Scientists and Physicians recommended that ‘pupils should be given an overview, grounded in intuition [*Anschauung*] and observation, of the richness of forms existing within the worlds of plants and animals’. Authors of and commentators on wallcharts strongly emphasized this aspect. For instance, in introducing the *Schädlingstafeln*, to which we have already referred, Frickinger wrote:

Youth requires one thing, it is not satisfied with the spoken word, it wants visual material (*Anschauungsmaterial*), good visual material. The use of such material is our foremost means of awakening the abiding interest of the young.³¹

An anonymous reviewer of Pfurtscheller’s wallchart gave it as his opinion that: ‘In teaching, words alone are not enough. To reinforce them we really need adequate images to be available.’³² And Carl Bopp judged that, ‘No explanations by the teacher can bring understanding when they are not made on the basis of elementary images.’³³ While the Dodel-Ports stated, in the preface to their botanical atlas: ‘Natural, scientifically reliable wallcharts can replace a natural object in classroom teaching and in lectures; they are more enlightening than the spoken word.’³⁴

WALLCHARTS AND SCIENTIFIC COMMUNICATION

One of the most striking things when looking at wallcharts is that they are not instantly intelligible. For instance, in the series by Heinrich Jung *et al.*, *Neue Wandtafeln für den Unterricht in der Naturgeschichte* (New wallcharts for teaching Natural History, 1894), figures are simply displayed on a black background without any caption or explanation (Figure 14). In several cases, description was provided by the teachers using their specialized knowledge and the explanatory booklet (*Begleitheft*) that was provided together with the wallcharts. This method had two significant implications. First, it called for greater involvement and participation both on the part of the teacher, who was usually supposed to know the text by heart, and of the pupils. If we go back to Hartinger’s series of fungi (Figure 2), it is interesting to observe that the names of the different types of fungus are not printed on the wallchart. In fact, there was a transparent overlay, with the names, to be placed over the wallchart itself. By virtue of this and other similar arrangements, the pupils could first be shown images together with their names and salient features, and later be asked to recall such elements by looking only at the wallchart.³⁵

31 ‘Aber die Jugend...will eines: sie gegnügt sich nicht mit dem gesprochenen Wort, sie will Anschauungsmaterial, gutes Anschauungsmaterial. Erst an Hand von diesem wecken wir ihr nachhaltiges Interesse!’ H. W. Frickinger, *Die Schädlingstafeln der Deutschen Gesellschaft für angewandte Entomologie*, Halle, 1917, 2.

32 ‘Das belehrende Wort allein genügt jedoch nicht. Zu seiner Unterstützung sind vielmehr geeignete Bilder erforderlich’. Anonymous reviewer, *Zeitschrift für Lehrmittelwesen und pädagogische Literatur* (1971), 7, 4.

33 ‘Aller Erklärung des Lehrers nie recht zum Verständnis kommen, weil die zu Grund liegenden elementaren Anschauungen fehlen’. Bopp, *op. cit.* (26), p. iii.

34 ‘Naturgetreue, wissenschaftlich zuverlässige Wandtafeln können beim Klassen-Unterricht und bei Vorlesungen die Vorweisung der Naturkörper selbst am besten ersetzen; sie belehren mehr als das lebendige Wort.’ A and C. Dodel-Port, *op. cit.* (20), p. ii.

35 ‘Die Wandtafeln sind nicht nur bei der Neudurchnahme, sondern auch bei der Wiederholung zu benutzen’, F. May, *Methodik der Naturkunde auf Grunde der Reformbestrebungen*, 4th edn, Düsseldorf, 1909, 132 ff.

The second implication was that the same image could be used for different types of student, at different levels of education. The Dodel-Ports noted of their botanical atlas:

We had in mind not only the needs of *Hochschule*, but also those of the *Mittelschule*. Pupils of different age have mainly been badly served in regard to schematic representations of all kinds, that it is actually difficult for them to gain a correct understanding of natural living things... Accordingly, the *Anatomisch physiologische Atlas der Botanik* will be designed to be used at every level of botanical teaching and in every branch of botanical knowledge.³⁶

This use of images as a 'universal' means for communication across different areas and levels of knowledge, was also meant to bridge the gap between teaching and research. Among the authors of series of scientific wallcharts there were not only school teachers but also distinguished scientists such as the zoologist and paleontologist Karl Leuckart (professor of zoology at the University of Leipzig), the geologist Eberhard Fraas (1862–1915, Konservator at the Naturalien-Kabinett of Stuttgart), the geologist and palaeontologist Karl Alfred von Zittel (1839–1904, the 'leading teacher of palaeontology in the nineteenth century and the only encyclopedist of the subject')³⁷ and Gaston Bonnier (1853–1922, professor of botany at the Sorbonne). (See Figures 15, 16, 17.) As Otto Schmeil wrote:

It is without question one of the first duties of a teacher to keep abreast with the present state of research; because otherwise he would be teaching ideas that have had their day or things unfounded in science, and either erect a crumbling ruin or an imaginary castle in the souls of his pupils.³⁸

A similar point was also made by Arnold Dodel-Port:

[School teachers,] who have the first word on what should be included in or excluded from teaching, have requested the authors of this work not to hesitate to include in the charts, without reservation, everything that should be taken into account from the point of view of science.³⁹

It is certainly interesting, from this perspective, to look at a wallchart about Coelenterates by Leuckart (Figure 18). It was in fact Leuckart himself who, in 1847, introduced the division of Cuvier's Radiata into Coelenterata and Echinodermata.⁴⁰ Clearly, the degree of

36 'Wir hatten nicht allein das Bedürfnisse der Hochschule, sondern auch diejenigen der Mittelschulen ins Auge gefaßt. Die Schüler aller Unterrichtsstufen werden häufig so sehr mit schematische Darstellungen aller Art gemisshandelt, dass sie gerade deswegen das richtige Verständniss der lebenden Naturkörper nicht erlangen... So wird der "Anatomisch physiologische Atlas der Botanik" auf allen Stufen des botanischen Unterrichtes und in allen zweigen des botanischen Wissens verwendbar sein.' A. and C. Dodel-Port, op. cit. (20), pp. i–ii.

37 H. Hölder, 'Karl Alfred von Zittel', *DSB*.

38 'Der Lehrer... so ist es fraglos eine seiner ersten Pflichten, sich über den derzeitigen Stand der Wissenschaften zu orientieren; denn im anderen Falle würde er ja wissenschaftlich längst überlebte oder wissenschaftlich nicht feststehende Tatsachen lehren, entweder eine morsche Ruine oder ein Luftschloß in dem Geiste seiner Schüler aufbauen.' Schmeil, 1896, quoted in Seybold, op. cit. (12), 233.

39 '[Die Lehrern], welche in Sachen des pädagogischen Taktes das erste Wort über das zu reden haben, was vom Unterricht auszuschliessen sei und nicht, haben die Herausgeber des Werkes gebeten, alle Bedenken fallen zu lassen und in den Tafeln ohne irgend welche andere Rücksichten alles das darzustellen, was vom Standpunkt der Wissenschaft aus in erster Linie zu berücksichtigen sei'. A. and C. Dodel-Port, op. cit. (20), p. i.

40 H. Schadowaldt, 'Karl Georg Friedrich Rudolph Leuckart', *DSB*.

actual involvement of scientists in wallchart production was not always as high as in the case of Leuckart (his series of wallcharts was specialized and prepared mainly for the later years of the gymnasium and for university studies), or A. Dodel-Port (who discussed the selection of images for his *Anatomisch-physiologisch Atlas der Botanik* with a committee of botanists during the 50th Meeting of German Scientists and Physicians in Munich), and one may legitimately entertain the suspicion that some of the researchers were simply hired by publishers to act in a supervisory capacity or even merely to confer scientific legitimacy on a series of charts.

Later wallcharts such as those presented in Figure 19 (1920) and Figure 20 (1963), also include visual metaphors, for example a man as a factory and the liver as a storehouse. It is worth quoting here Dodel-Port, an enthusiastic follower of Charles Darwin,⁴¹ who also considered educational tools such as wallcharts an important channel for spreading ideas and theories.

Our greatest gratitude goes to a person who took active part in our work at its beginning and who is unfortunately no longer among the living: Charles Darwin... He was very much pleased by some of these wallcharts – may they be passed on to future generations of his disciples.⁴²

CONCLUDING REMARKS

The emergence and flowering of wallchart production in late nineteenth-century Germany was made possible by a unique combination of several elements: structural transformations within the educational system, trends in scientific practice and pedagogical thought, and artistic skills. Thus wallcharts, and in particular scientific wallcharts, represent a valuable source for the study of the historical development of these different areas and for their reciprocal interrelations, particularly since some of their authors and editors operated simultaneously within more than one area. Ideas about the most appropriate forms and content for the teaching of biology in school and universities were derived from theories about the nature of a discipline, its place in society and its relations to other practices (such as fine art). A group of scholars has even gone so far as to suggest that wallcharts might be seen as mirrors of a *Zeitgeist*, since they capture through their style and content the intellectual ‘spirit’ of a certain historical period.⁴³

In any case, wallcharts undoubtedly remind us of the crucial role that visual media play in scientific education and in scientific communication in general. Together with scientific apparatus and with laboratory practice, images are an important element in teaching science and, given their non-verbal, more direct appeal, they can also communicate to different kinds of audience and different types of practitioner.

41 See the lectures collected in A. Dodel-Port, *Moses oder Darwin? Eine Schulfrage*, Zürich, 1889.

42 ‘Der verdientesten Einer, welche am Fortgang unseres Werkes regen Antheil genommen, ist leider nicht mehr unter den Lebenden: Charles Darwin... Er hat an manchem dieser Blätter seine helle Freude gehabt – möge diese nun an seine kommende Schüler übergehen.’ A. and C. Dodel-Port, op. cit. (20), p. iii.

43 W. Müller, ‘Schulwandbilder als Spiegel des Zeitgeistes?’, in *Die weite Welt im Klassenzimmer. Schulwandbilder zwischen 1880 und 1980*, Exhibition Catalogue, Cologne, 1984. R. Stach et al., *Schulwandbilder als Spiegel des Zeitgeistes zwischen 1880 und 1980*, Opladen, 1988.