Zeitschrift:	Archives des sciences [2004-ff.]
Band:	67 (2014)
Heft:	2
Artikel:	The synoptic scientific image in early modern Europe
Autor:	Daston, Lorraine
DOI:	https://doi.org/10.5169/seals-738383

#### Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. <u>Siehe Rechtliche Hinweise.</u>

## **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. <u>Voir Informations légales.</u>

#### Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. <u>See Legal notice.</u>

**Download PDF:** 19.11.2024

ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch

# The Synoptic Scientific Image in Early Modern Europe<sup>\*</sup>

# Lorraine DASTON\*\*

#### I. Seeing the Impossible

Historians of Renaissance and early modern European art have long remarked on the many ways in which drawings and paintings gave viewers a glimpse of the impossible. By this I mean not only the obvious examples: images of fabulous creatures like



Fig. 1. Centaur, Ulisse Aldrovandi, Monstrorum historia (Bologna, 1642): 31. © Biblioteca Universitaria di Bologna.

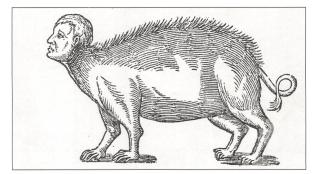


Fig. 2. Man-Pig, Ambroise Paré, Des monstres et prodiges (1573), éd. Jean Céard (Genève, 1971): 64. Reprinted by permission of the Librairie Droz, Geneva.

the centaur (Fig. 1) or monstrous hybrids like this man-pig (Fig. 2). Rather, I have in mind more subtle impossibilities, in which the cunning of the artist panders to a certain yearning to see more broadly, deeply, or sharply than located human vision ever could.

This kind of illusion goes well beyond the *trompe l'oeil* mimesis of the still life, which after all only tricks the eye into thinking that the two-dimensional painting is a three-dimensional arrangement of perfectly possible flowers, fruits, and other objects. Instead, the illusion stretches human vision to superhuman feats of panoramic sweep (Fig. 3)<sup>1</sup>, integration of multiple viewpoints (Fig. 4)<sup>2</sup>, or simultaneous focusing of foreground and background (Fig. 5)<sup>3</sup>. These are not images of impossible objects but rather of impossible seeing.

In this article, I would like to explore a kind of impossible seeing attempted time and time again in sixteenth- and seventeenth-century natural history, natural philosophy, and even mathematics : synoptic seeing, or seeing everything all at once, in one glance. The "everything" in question could be the patterns of the prevailing winds across the globe or the type of a plant genus emerging from many individual species or the hidden regularities in the fluctuations of the weather or even the essential features of state admin-

Marion Hilliges, " Der Stadtgrundriss als Repräsentationsmedium in der Frühen Neuzeit, " in Tanja Michalsky, Felicitas Schmieder and Gisela Engel, eds., Aufsicht – Ansicht – Einsicht: Neue Perspektiven auf die Kartographie an der Schwelle zur Frühen Neuzeit (Berlin : trafo Verlagsgruppe, 2009), pp. 351-368, on pp. 354-5; Naomi Miller, Mapping the City. The Language and Culture of Cartography in the Renaissance (London : Continuum, 2003), pp. 185-8.

- <sup>2</sup> Miller, Mapping the City, pp. 174-6.
- <sup>3</sup> James Ackerman, Distance Points. Essays in Theory and Renaissance Art and Architecture (Cambridge, MA: MIT Press, 1991), pp. 187-8.
- \* Adapted from an adress at the award of the Pictet SPHN medal prize held in Palais Eynard, City of Geneva, Geneva the 29th October 2014.



Fig. 3. Jacopo de Barbari , View of Venice (1500). © Trustees of the British Museum.



Fig. 4. Leonardo da Vinci, Plan of Imola (1502), Windsor, Cod. Atl. 12284. Royal Collection Trust / ©Her Majesty Queen Elizabeth II 2014.

istration. In each of these cases, vast amounts of information gleaned from many observers dispersed over centuries and continents had to be distilled into some kind of compact representation: reports from mariners at sea, from generations of botanists, from networks of weather-watchers, or from the stacks of records stored in state archives. The representation in question could be and often was verbal: a terse summary, a list of key points, a short description. But just as often, the representation was visual: a synoptic image that made seeing patterns, essences, and regularities all at once literally possible.

ARCHIVES DES SCIENCES



The standard term for this kind of taking in of a complex state of affairs all in one glance is the *coup d'oeil*. It originates in an early modern military context of surveying a battlefield from a hilltop or other high vantage point in order to gain a literal overview of a situation that would be a swirling, shouting, bloody confusion of soldiers, horses, carts, and cannons on the ground. By the late eighteenth century, the *coup* d'oeil had become a standard part of the training of military engineers in France, Prussia, and elsewhere.<sup>4</sup> Although military officers disdained the consultation of maps as no substitute for a thorough firsthand survey of the territory<sup>5</sup>, we still associate the *coup d'oeil* with the bird's-eye view of a city, of which many early modern examples survive. Historians of cartography have pointed out how these bird's-eye views shade into, on the one hand, landscapes (Fig. 6), and, on the other, views of military fortifications (Fig. 7).<sup>6</sup> What is

Fig. 5. Albrecht Dürer, Feldhase (1502). Watercolor, ©Albertina, Vienna.

significant about these bird's-eye views for my purposes is that the impression of the coup d'oeil, of seeing everything at a glance, is in fact achieved by seamlessly integrating multiple points of view. No hilltop or church bell tower was ever high enough yet also central enough to give a single observer the entire city in all the desired detail. These bird'seye view city maps were usually mosaics of multiple views from different vantage points pieced together like parts of a puzzle, a process repeated by the printer who fitted together multiple woodcuts, as in the case of the gigantic Barbari view of Venice (Fig. 3). What the viewer sees is in fact not a bird's-eye point of view but rather more like an angel's-eye point of view, which merges all the individual perspectives into one synoptic image.

I shall argue that this is what early modern scientific images also tried to do: merge many different observations into a synoptic image. Because the kinds of observations were various, so were the images. Tables of weather observations do not look much like botanical illustrations. Yet the very same language of the *coup d'oeil*, of seeing everything at one glance, was repeatedly used in both cases, different as the subject matter and the methods of observation were. Early modern naturalists were confronted with a novel problem that had hardly troubled their predecessors: how to combine multiple observations of the same subject matter - be it a comet, human anatomy, plants, snowflakes, or storms. The synoptic image was one solution. My argument unfolds in three parts: first, how combining multiple observations became a problem; second, two seventeenth-century examples of how synoptic images were used to solve the problem, one from botany and the other from meteorology; and *third*, some concluding reflections about the kind of impossible seeing these synoptic images provided.

#### II. Too Much to Observe

Sometime around the middle of the seventeenth century a kind of observational mania seized the European Republic of Letters. In the German city of Schweinfurt, a handful of municipal physicians

<sup>&</sup>lt;sup>4</sup> (Frederick II of Prussia), Esprit du Chevalier de Foulard tirée de ses commentaires de Polybe (Berlin : Chrétien-Frédéric Woss, 1761), pp. 1-35.

<sup>&</sup>lt;sup>5</sup> Ibid., p. 19.

<sup>&</sup>lt;sup>6</sup> Miller, Mapping the City, pp. 151-158, 179; Hilliges, "Der Stadtgrundriss als Repräsentationsmedium in der Frühen Neuzeit, "p. 355; Daniela Stroffolino, "Rilevamento topografico e processi construttivi delle 'vedute a volo d'ucello', "in Cesare de Seta and Daniela Stroffolino, eds., L'Europa moderna. Catografia urbana e vedutismo (Naples : Electa Napoli, 2001), pp. 57-67.



Fig. 6. Albrecht Dürer, Nemesis (Das große Glück) (1501), over the village of Klausen im Eisacktal. Engraving, ©Albertina, Vienna.

founded the Academia Naturae Curiosorum and sent out a call to colleagues all over Europe to send in observationes of natural rarities, from double refraction to monstrous births, to be published in the academy's aptly named journal, the Miscellanea curiosa.7 (Fig. 8) In Paris the newly installed director of the observatory, the Italian astronomer Gian Domenico Cassini I, opened the first of many bound folio volumes and began recording his observations of everything from lunar eclipses to visits by court dignitaries.<sup>8</sup> Across the city at the Bibliothèque du roi in the Louvre, Claude Perrault and his colleagues at the Académie Royale des Sciences were dissecting animals: ostriches, tortoises, bears.<sup>9</sup> (Fig. 9) In London, natural philosopher and Fellow of the Royal Society Robert Hooke wrote: "there is scarce one Subject of millions that may be pitched upon, but to write an exact and compleat History thereof, would require the whole time and attention of a man's life, and some thousands of Inventions and Observations to accomplish it."<sup>10</sup> (Fig. 10) Everything

Fig. 7. Palmanova, Georg Braun and Frans Hogenberg, Civitates orbis terrarum (1598).

and anything could be, should be observed – if only there were world enough and time.

- <sup>7</sup> Miscellanea curiosa medico-physica Academiae Naturae Curiosorum, vol. 1 (Leipzig: Johannes Bauer, 1670); Andreas Büchner, Academiae Sacri Romani Imperii Leopoldino-Carolinae Naturae Curiosorum Historia (Halle/Magdeburg: Johann Gebauer, 1755), pp. 193-195.
- <sup>8</sup> Gian Domenico Cassini I, Journal des observations faites à l'Observatoire 1671-1674, AD 1.1, Bibliothèque de l'Observatoire de Paris; Guy Picolet, " Une visite du jeune Saint-Simon à l'observatoire de Paris," *Cahiers Saint-Simon*, nr. 26 (1998): 59-68.
- <sup>9</sup> Claude Perrault, " Proiet pour les Experiences et Observations Anatomiques, " (15 January 1667), MS. Proces-Verbaux, vol. 1 (22 December 1666-April 1668), Archives de l'Académie des Sciences, Paris ; Académie Royale des Sciences, Mémoire pour servir à l'histoire naturelle des animaux et des plantes (Amsterdam : Pierre Mortier, 1736).
- <sup>10</sup> Robert Hooke, "To the Reader," *Lectiones Cutlerianae* (1679), reprinted in R.T. Gunther, *Early Science in Oxford*, vol. 8 (London : Dawsons (1931) 1968), n.p.

ARCHIVES DES SCIENCES



Fig. 8. Monstrous birth, Johann Georg Greisel, Observatio LV, Miscellanea curiosa medico-physica Academiae Naturae Curiosorum (Leipzig, 1670): 152. Reprinted by permission of Max Planck Institute for the History of Science, Berlin.

Nature was vast, various, and variable; experience as limited as the human senses, intellect, and lifespan. The only way to bridge the gap between infinite nature and finite human lifetimes was to create an army of observers, spanning continents and centuries: collective empiricism. The newly formed scientific academies of the seventeenth century like the Academia Naturae Curiosorum (late the Leopoldina, established 1652) or the Académie Royale des Sciences in Paris (established 1666) tried out various models to organize the gigantic work of collective observation. The Academia tried to recruit volunteers who would send in observations from near and far to be published in their journal; the Paris Académie at first performed all observations and experiments together at their meetings; the Royal Society of London (established 1660) combined both forms. Some prophets of the new natural philosophy,

ARCHIVES DES SCIENCES

such as Bacon and Descartes, thought it would be better to rely on the paid labor of servants to conduct observations and experiments; the academies instead attempted to attract members and correspondents who would work together on a more egalitarian basis. But whatever form collective observation took, multiple observers had to be coordinated and multiple observations had to be combined.

The challenge of integrating multiple observations was still new in the late seventeenth century. During the sixteenth and seventeenth centuries, the nature of observation had been dramatically transformed. What had since Antiquity been a practice associated with what Cicero had called the "natural divination"11 of sailors, shepherds, and peasants became a prestigious pursuit for scholars. What had throughout the Middle Ages had been a specialized term linked to monastic timekeeping and astrometeorology spread to philology, medicine, jurisprudence, natural history, anatomy, and natural philosophy: by the turn of the seventeenth century, observationes and its vernacular cognates featured prominently in titles of scientific and medical treatises, travelogues, humanist compendia, and a great deal that defies ready description, an expansive trend that persisted well into the eighteenth century.<sup>12</sup> Observatio and experimentum, two words rarely coupled in medieval Latin, became by the latter half of the seventeenth century as inseparable as left and right and, by the mid eighteenth century, were invariably defined in contradistinction to one another, as the foremost forms of "learned experience".<sup>13</sup>

<sup>11</sup> Cicero, De divinatione, I.vi.

<sup>2</sup> Katharine Park, "Observation on the Margins, 500-1500," Gianna Pomata, "Observation Rising: Birth of an Epistemic Genre, 1500-1650," and Lorraine Daston, "The Empire of Observation, 1600-1800," in Lorraine Daston and Elizabeth Lunbeck, eds., *Histories of Scientific Observation* (Chicago: University of Chicago Press, 2011), pp. 15-44, 45-80, 81-113. Based on a preliminary bibliography prepared by Sebastian Gottschalk, using the online catalogues of World Cat, the British Library, the Library of Congress, and the Herzog-August-Bibliothek Wolfenbüttel, and counting titles in Latin, French, Italian, German, and English, circa 82 titles were published 1550-1599, 98 from 1600-1649, 246 from 1650-1699, 681 from 1700-1750, and 1988 from 1751-1800. These figures of course give only a rough indication, but the relative increases are probably reliable.

<sup>13</sup> See for example the distinction between "gemeine" and " gelehrte und kluge Erfahrung", and under the latter heading, between "die Observation" and "das Experiment" in Johann Georg Wald, "Erfahrung", *Philosophisches Lexicon* (1775), 4<sup>th</sup> ed. (Hildesheim: Georg Olms, 1968), pp. 1082-84. More generally, see Hans Poser, "Observatio, Beobachtung," in Joachim Ritter and Karlfried Gründer, eds., *Historisches Wörterbuch der Philosophie* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1984), vol. 6, cols. 1072-1081

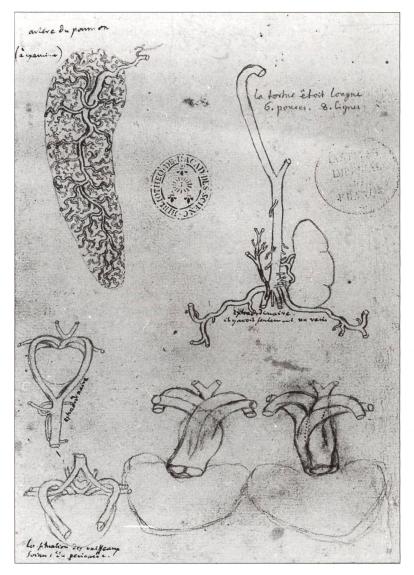


Fig. 9. Tortoise heart and lungs [c. 1667], Sébastien Leclerc, Histoire des animaux, © Académie des sciences – Institut de France, Paris.

Royale des Sciences that witnessed observations and experiments communally whenever practicable<sup>14</sup>; more often it was a virtual one, called into being by epistolary exchanges, the circulation of manuscripts and publications, lineages of ancestors and successors, or organized networks of far-flung informants armed with instructions and questionnaires. In the context of the multiple early modern movements to reform natural philosophy, empiricism always implied "collective empiricism"<sup>15</sup>: isolated, private observations were meaningless.

Observation had for millennia been imagined as a collective enterprise, but the collective in question had stretched over time, not space: medieval astronomers drew on the observations of Ptolemy, who in turn drew upon those of Hipparchus, who in turn drew upon those of the ancient Babylonians. When Aristotle wrote in *On the Heavens* that the heavenly bodies had since time immemorial traced regular circular trajectories, he was relying on a treasury of observations already

The emergence of observation as a cultivated form of learned experience had profound epistemic implications that were closely intertwined with the social organization of the early modern European Republic of Letters. Individual savants often conducted their observations by themselves, but they seldom did so for themselves alone. However possessive learned observers might have been of their findings conceived as intellectual or personal property, they understood the significance of their activities in the context of a collective. Sometimes this collective was a literal one, as in the case of the Paris Académie

<sup>&</sup>lt;sup>15</sup> Lorraine Daston and Peter Galison, *Objectivity* (New York : Zone Books, 2007), pp. 19-27.

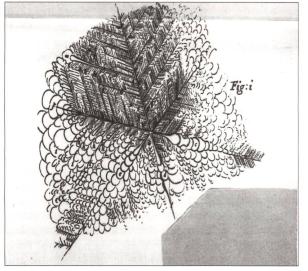
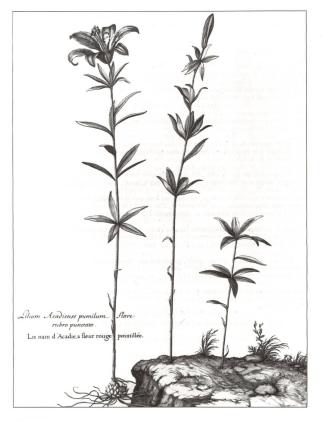


Fig. 10. Crystalline formation in frozen urine, from Robert Hooke, Micrographia: Or some Physical Descriptions of Minute Bodies Made by Magnifying Glasses (London 1665).

<sup>&</sup>lt;sup>14</sup> Mémoires de mathématique et de physique. Année MDCXCII. Tirez des registres de l'Académie Royale des Sciences (Amsterdam, 1723), "Avertissement ", sig. 2r; Denis Dodart, Mémoires pour servir à l'histoire des plantes (Paris: Imprimerie royale, 1676), "Avertissement ", n.p.



<sup>16</sup> Aristotle, On the Heavens, I.iii, 270b12. It was believed that Egyptian and Babylonian records went back hundreds of thousands of years: Aristotle, On the Heavens, trans. W.K.C. Guthrie, Loeb Classical Edition (Cambridge, Mass.: Harvard University Press, 1971), p. 24-5n.

Fig. 11. Lilium acadiense pumilum, drawn by Nicolas Robert,
from Denis Dodart, Mémoires pour servir à l'histoire des plantes
(Paris, 1676). ©Muséum national d'Histoire naturelle
(Paris) - Direction des bibliothèques et de la documentation.

many centuries old.<sup>16</sup> This was a literate tradition, and astronomical observations were sometimes individually attributed, as in the case of Hipparchus – a sign of how rare and precious they were, costly in terms of time, money, and skill. In contrast, the observations of natural phenomena encoded in proverbs about the weather, navigation, and farming were anonymous and orally transmitted, but they too accreted through the slow, cumulative labor of generations upon generations.

The challenge to self-consciously scientific experience in the latter half of the seventeenth century was to create a super-observer, compounded of many individual observers scattered over time and space. It was not enough for scientific academies like the Academia Naturae Curiosorum or the Royal Society of London or the Paris Académie Royale des Sciences to recruit scores of volunteers to send in observations on all and sundry to be published in their annals – the observational mania described above. Nor would it suffice for each observer to use the finest instruments, to insist upon firsthand inspection of the phenomena, to take scrupulous notes, and to write meticulous descriptions. The observations had to be knit together in order to permit the work of sifting

and comparison, the elimination of
errors and accumulation of facts,
and to go forward. Individual experi-
ence had to be melded into collec-
tive experience, individual observers
into the super-observer who strad-
dled continents and centuries like a
colossus.

#### III. Two Examples : Botanical Illustrations and Weather Tables

The super-observer produced the synoptic image. Here are two very different examples, one from the Académie Royale des Sciences in Paris and the other from the Royal Society of London, both from the late seventeenth century: (Figs. 11, 12). These images not only look different; some might object to calling the weather table an image at all. And they were certainly produced by different methods. Nonetheless,

1.	Weather (W	Je	mary.	8	12, 9.	Weather /	F	ebruary.	405. 3	12, 9.	Weather	Winds.	March	6. Beron. [7	12, 9.	Wother	Winds.	April.	Baron, Jhrohain,		officiality.	May.	6. 11	2.1	Weather	Wands	June	6, 1 Larons They
1	má þ	Eh.30 SE1	2040	9. 77		Far 1	WI	w	1- 43 54 77	48 10000	Pair		-		-	Reis	W by No	NW	194 17 91 39 <sup>103</sup> 31 540, 87	Fer	W by S : N W 1	NW	17. E4 112	-	Very De	SW 2	1 67 8 5	p. cd 192
E				43	a 61	Day	n' by So	www.			Sleet	NbyEs	_	40	80 0. 12	Rail	NNW		53 580. 07	Fer					Fil		S # by Sz	00118
		3 6 E 3	1	1. 70		Hury	sby Wo		21	01 100 3. 05	Fair		1 1	64	800. 04	Same	N.3	NE	\$1 92 \$3102 \$7 930, 14	Dry	the W a		a		Rein	on oyse	1 1 1	8:114
		1	iby W	\$7		Reit	SE 1	StyE			Hard Fre-						Na	N Eby N		Cloudy	SWI.W		47 1000	- 54		#1		50(11)
		b.Wz		47		Fair Smidlers			62		Cloudy	W by \$ a N by W2	NW	26	90	Free	NINE	NEbyN	75 93	Storen	W1 SW1	_	24 100 1	19				
	Fairer 15	W 4	SWbyW	44 50 72		Fair	Wa	W. W.	40	1	Rain		1	91	11 11 11 11 11 11 11 11 11 11 11 11 11		NE4 NWES		675 93 75 93 91 90 91 90 91 90 91 90 91 90	Ren	DW1		34 103					
	Fool	W4 W3	-	72	5-	Cloudy Canaly Feir Ballio	SWAWS WSWS WbySt	WSW	+	42 42 42 144 144 15 15 15 15 15 15 15	Gard	A 100 -	Nhow	11	29	Freitant	NEI	-	83 84 71 109 69 95	Pair Thunder	W 1981		17.10	-				
	Pdr		_		<u> </u>	Bain Smallfrox	WhySe	w	48	2	Cloudy Faiter Hard Pro	N by We		- 19	2	Cloudy	EWN		69.95	Ras Hor Fro			40 98	- 39	Fair		-	
	Ten Van	0		18. 67	03 . 75	Fair					Fair Cloudy	E.	N by E	29. 95	2	Cloudy	ESEI	5	53 99 45 (1)	Fác	SW3		511 50 52 821 69 807	01	and	W by \$ 2		72120
10	(mailing)	14.1		00 .41 80	15 +10	Violent	W1	WbyN	3. 9	10 1 1, 51 101 93 101 93 101	Fair	SE by S	3 by E	1 82	8.	Cloudy	2E by E	58	43 25	or a mer	Sby We Sby E	-	79 58	-		14 by 5 1	W by N	78131
		Wo.Wy	5 W		850. 05			NWIN	7	60		ESEO		82		Cold Fair	21		97 85 10 10 10 10	Fair		1	121 8 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	_		Pr 2		
	and b	W o W by S i	w S W	142		Cloudy Frit Cloudy	N W 4 Sby W 1	NW	20. 00	101	Fair	E by No	AL by I	30- 01		Citedy + Children	NbyW		17 98 12 102	Fair	51		93,148					
	Fair hard Fro.		-		-	Niching	W 3W 8	W by N	29. 88	100	Feel	NEO	-	11	-	Drops Cloudy	50	NW	17 98	Fer		-		-	Great			
	and			73		Fair			40. 07	17. 10	Cloudy	1		13					16 970. 53	end Warm	1.3	1	93 115		Drought			
1	Same	Eby Es	ESE	82	85	Hour bos. Scenewhat Pair	W J	N N W	,0, 05	81 169 93	Cloudy	NBYE		11	45	Fair	Shy Wa	3 W	23 98	Sinc	NEINBYE		\$0 93 83 147		Cloudy Fair	WhyNa	N#	67140
ł	-3/0-	Wa	wsw	60	103 0. 49	Cloudy	W 193 1	N W W by N	10. 98	87	Soul Rein	6 by No	-	06	86	- maintaine	NI		43 104		NITE		93 118 30. 00 117 10 150 21 108	-	Fit	10		78129
		WAW		71	99				21		140	S by W	1	14 570	925. 41	Rain	Ng	NNE	45 59 48 52 101 0- 07				10150		Not Cloudy	Eo		8711
		W by Sc W a		6	102	Pair Hery	5W1 5W1	NW	94 24	84	Cloudy	S by W	1	14	930. 18	cloudy	NE3		50 1010. 35 70111 80 59	Pair	NOT WI		17 105		Hot and Very De		ar by S	86.13
	Milling -	CALL M's	w by S w		940. 15	Hery Con.Rait	Well 4	w	-40	107 0. 03	Fuin	Sby W Sby E	-	78	97	Cloudy	-		81 59		NHE		10 100 10 110 08 137	-		E by Se	-	7012
	Clouit	W by 5 ;	W 59 3	43	93						Fairer		4	54	930. 03 03 807. 64	Cloudy	NE		86 \$7				68137		Aria	K by S 1	S E by S S by E	71 1 1
	Genty	N byW.	N 69	13	54 P. 14						Front Extr	Wo	1	80		Cloudy Fair	ENE	E	82104	Cloudy	NNE	1	05 100 05 110 03 110	-		15WJ.	S H' by S	80 *** 92 154
	-Jan Cloudy	NLw.	-	28, 13	02.0, 26	-	-	-			Cloudy	SWby S	wins	- 44	105	Rain Cloudy Rain	NDAN	8	301080. 11 \$1105 1. 05		ENET	NE	00113	-				-
			N by W		-	-344-		-					1	30. 02		Faleer		hw	6. 1010. 87	Same			52 140	_				
6	Cloudy		1			Cloudy			31	10. 1. 90	Fair Cloudy	SW1 SW1	wsw	62)	113	Cloudy	S by W		50 129 30 129		ENE	ENE	87 148 87 141					
		NW5.W	-		94	Cloudy	E by No	What	7	91054 910 91054 910 91059	Felt		S iny W	29. 59 E4	108	Fair	WSW.	-	11101	Citudy	ENE		78.118	-				
1	Fag	We		17	B		WNW	- 40	- 6	94	Reil	1	1	10. 11	930. 05	Fair	-		10 59 6. 11	Chudy	NEWE		78 211					
•						Beir and Penden	NW1			91 e. eg	Fair and Pleasant	d W z		1 19	1111	HoarPea Fuir	SE		14 85	Hot De	NEDIN		65115					
-	Fog	-	-	-		-Rain-	W by S a W by Na	-	71	470. 43	Cloudy		-	20 42	-	Rain Fairer	Els		34 100		Na	Nink	- 77 124	-			$\vdash$	
	hard Fro.	-	_	- 14	77	Fred	WSW		54	10		SWAW		27	108				11 10 0 41 41 139 41 139	Far	NEWE		80118 810.40 80110	_				
٠II	Fair	SbyE			2	and	waw,		10. 01 10. 01	80	Cloudy Fair Cloudy		3 4 w S w	47	10:01 05	Hour Fro Fair	100		1 1 1	Same	NE: E by S:		26-10 26-44 24-10	-	Some Cloudy	WNN		88 141
	freed byn.	TE	ENE	-	78 64 84	Goudy	WSWI	WNW	54	222	Fair	5.83	Wigs	- 39	22	Cirely	5 5 W 2	SW.	- t4 115		NNE		81110	-1			NNH	93'128 95'150 98'16'
н					<u>i</u>	Fairer			<u>91</u>	90	Rain		1	40	ach 25	Wares 3 Fale				Fac	NES		80113 76148 75110			51	NK	98.15
	and Feir	E by N	EbyN		77 85 84	Seet	NW;	WNW	72	84 100 790. 09	Fair Cloudy	WSW SW1	w	50 53 55	82	Cleady	W SW C W by S :	w	10 57 10 10 007 10 10 07 10	Het and	NEI		72 112			-		
11	Couly	NET	-	19	87	Hand Free	NW1	-	- 1	75		Sty E	IS by W			Fairer Fair	SWAW:	-	90100	Dy Obudy	NE toN.	NWE	66+19	-	Fair			
	Feir final Fro	EbyNo	-	-19	*	Fair Sove Cloudy	NNW		- 10	85 920. 40		S by Wa		P	18 . 45	and Pirafest	W SW S		233	Fit	21	N	59134		Not	5 Z 1		98 161 98 141
ш	and Putr	Z a			88 78	Eleftring	[				Cloudy Fair Thester	5 4 ¥	135W		10 0. 57	Fair	ssw,	wsw	74 109		NNES	NbyE	43 117		Yar Sultry	N by W 1	8	\$4.740 \$4.10
	Froft and Fair Pies	E .	-		71	Pair	AW LOW	NW		41 103 08 46 0. 08 104 51	Cloudy	W a	W	0.1 1	49 <sup>0</sup> . 39	Fair	SWAW	w	64 100	Feir	NNWI	N by W	source o	68		P	TTOTAL T	
1	Sant Duy		_	- 69	79	Cloudy - Rain Feir and Finalant	w .	WNW	75	100	Fair		1	31 L 58	17	Rain			17105	Huil Fair	NNW I Nby We		5 8002 5 5120 5 700 7 0	61	Hot	W by S I		87 166 83 144
١I	Same	E 1		05	íi I	Finiat	WhyNa		27	104	Hoar Fra Fair Rais	Shy.W.	{	- 50 - 50 - 41	82	Fair Cloudy	SWAW4		12-090. 71	Far Bain	Chy SI SW: Wo	N by W W by S	50004 57010				r by N	76 142
	Froft and Coudy	E NE a	*	76	70	Reis	Worss NWLW2	WbyN	- 77	59	Fair Rain and	80	WSW	44		Fair	SWI	-	38 91				64109		-	NH's	W by N	84714 58185
Ш				- 50 - 48		Fair Cloudy			73	59 920. 45 93	Heil	P°		14	10 41	Cloudy	WbySt		31 124			\$ I	671.40		Same	3. 1	19	- 01158
ш			SEbys	47	1.		,		20	**	Rain	NNWE		31	pa 41	Fair Drops of Rais	W by No	N by W E by N	52 85	Fair Fair Saltry	Z I	SE	61 132 51 150 58 151	-1	Same	WSW2 WNW2	8	P01123
II	Ford	Way Se	W by N	80	#1 991. 51		-		-	10	Feir	-				Hoar Fro				Saliry	Lo	ESE	58191	-		INWI		69125
п	Rein			72	92 98						Rain Fair			38.9	0. 10	Fair	21	N by E					11	7	Same	1 67 51		551743 59743
	Warm 1	1	S S by W S W by S	44	19 h		1	1				WbySt	w	\$0 5 55215 10 5	13	Cloudy Cloudy Fair Cloudy.	E o S by W 1	N by W	78,000			i		-1	Same 1	W DWS	10	\$9135
	Couly	by W z	W5W	411	of 0. 17		-			1-1	Fair Cloudy	WNW	-	20 5	1_	Cloudy.	NEDYNG	-	26743 87212	Not				_		5 1 3		\$7139
11.	Reis E	Iz.	552	171	1. 91		- 1	1		5 05	Fair Bain	NNWS		35,00	01. 64					and		1	1 1	-1				

AREGISTER of the Weather, Bearing of the Winds, Flying of the Clouds, Height of the Marcury in the Barometer, and of the Spirits in the Thermometer,

Fig. 12. Weather Table from William Derham, "Part of a Letter from the Reverend Mr Derham to Dr Sloane, Giving an Account of His Observations of the Weather for the Year 1699," Philosophical Transactions 22 (1700-1): 527-529.

Sauh. hilt	. Dio torides	- Mathiolas. . Saracues
Bauh pinase . Prodromus.	. Dioscovidio Notha.	- Launa nikit - Euryoius Orders botanolog - Val. Cordus. ( wikit.
	. Hippoerates.	- Val. Cordus. Cumu.
	Theophrastus.	Bodayud
King California and and	Plinines Actionus.	Launa. Dalechampius.
· him in an in an	. Galenus. Columella	-Lattad
and the second and the second	Outradied	. Cornarnat.
	Filius Macer.	r Scholieftes
	Geoponica. Lortan.	Liebone
had a sub rand marke	- Ruellins Brunt	clines .
	Tragued. Fruche	
	Lobel Dodongus & Dalahamp.	Judius
	Serapio.	
	· Anterior Sugar ·	
all and an interest	. Aristophanes.	
	· X enophon · American Marcellin,	
	- Erasmus.	the second s

both aimed to compress the results of many observations into a compact visual object that could be seized at a glance. How was this done?

Consider the case of the botanical illustration. In January 1667, less than a month after the Parisian Académie Royale des Sciences had held its first official meeting, the architect and physician Claude Perrault proposed ambitious projects in comparative anatomy and botany.<sup>17</sup> At the Académie's quarters in the Bibliothèque du Roi in the rue Vivienne, a team of anatomists, assisted by several artists, dissected a camel, a bear, a chameleon, a pelican, an ostrich, and other such animals as came their way, usually via a death at the royal menagerie.<sup>18</sup> Across town at the Jardin du Roi, botanists and artists under the direc-

<sup>17</sup> Claude Perrault, "Proiet pour les Experiences et Observations Anatomiques, "15 janvier 1667, Procès-Verbaux, t. 1 (Registre de physique, 22 décembre 1666-avril 1668), pp. 22-30; and idem, "Projet pour la Botanique, "ibid., pp. 30-38. Archives de l'Académie des Sciences, Paris. Perrault's original manuscript, which diverges in some places from the fair hand minutes of the meeting, is preserved in the Pochette de séance for 15 January 1667. Records of the chemical analyses performed on plants are preserved in the Fonds Bordelin. Archives de l'Académie des sciences, Paris. The fortunes of the project are described in Alice Stroup, A Company of Scientists: Botany, Patronage, and Community at the Seventeenth-Century Parisian Royal Academy of Sciences (Berkeley: University of California Press. 1990).

<sup>18</sup> Alice Stroup, A Company of Scientists: on 39.

tion of physician and academician Denis Dodart meticulously described live plants cultivated in the garden or herbarium specimens collected from far and wide.

In the projects undertaken by seventeenth-century scientific academies, the community of observers embraced the near and the distant, the living and the dead: not only the academicians, their artists, and their dispersed correspondents, but also past naturalists stretching back to Antiquity. Although one explicit motivation for both Paris Académie

projects was to correct the errors of older authorities like Pliny and Dioscorides, their works were still regularly consulted as part of the compilation of observations that made comparisons and generalizations possible. (Fig. 13) The manuscript title page for the entry "Nasturtium" of the *Histoire des plantes* lists all of the ancient and modern botanical works consulted in its preparation, just as the most oft-consulted early modern botanical reference work, Caspar Bauhin's *Phytopinax* (1596) commenced with registers of both authors cited and correspondents who had sent in specimens, botanists past and present alphabetized by first name, Aristotle rubbing shoulders with "Felix Platter doctor from Basel" and



Fig. 14. "La Grande Absinthe," MS 450, Muséum national d'Histoire naturelle, Paris. ©Muséum national d'Histoire naturelle (Paris) - Direction des bibliothèques et de la documentation.

"Ulisse Aldrovandi doctor from Bologna."<sup>19</sup> A manuscript instruction from the Paris Académie's natural history of plants project exhorts artists and assistants: "I repeat what I have said before: it is absolutely necessary before starting to work on the description of any plant whatsoever that has already been described and figured to look at as many of these descriptions and figures as possible."<sup>20</sup>

The hands and eyes (and sometimes the tongues and noses) of all the observers of the natural history of plants projects were coordinated by close supervision and constant correction. Stacks of manuscript instructions, now preserved at the Bibliothèque du Muséum national d'Histoire naturelle (the successor institution of the Jardin du Roi), reveal how the senses of the botanists and artists were schooled to see, taste, and describe in unison. Each sheet is headed with the name of a plant species and contains detailed queries and replies. Take this typical example of queries relating to wormwood (Fig. 14). The questions direct the attention of the observer by demanding closer investigation ("I. La graine? par le microscope."), requesting further details ("III. La feülle et la tige sont elles vertitablement velües? voir a la loupe."), or directing the observer to focus more sharply on color, texture, and taste ("IV. La racine est elle vrayment amere?").

The copious and exacting instructions, paired with the laconic and occasionally dissenting replies in different hands, bear witness to a struggle between ways of seeing, touching, smelling, and tasting. Were the roots of the Aconitum salutiferum fringed or furry (as Camerarius had figured them)? Were the tips of the Geranium Robertianum primum brown, yellow, or brown dusted with yellow pollen? What did the Aconitum flore Delphinii smell like? Did the roots of *Fraxinella officinis* taste insipid or bitter? The style of seeing and describing enforced by these queries and instructions was relentlessly comparative: not only were artists and assistants sternly reminded to consult all previous descriptions and figures in older botanical works before beginning their own; the single most oft-repeated exhortation was to repeat an observation, both to check that of a predecessor or to sharpen one's own.

<sup>19</sup> Caspar Bauhin, FUTOPINAX, seu Enumeratio plantarum herbarijs nostro seculo descriptarum, cum earum differentijs (Basel: Sebastian Henripetrus, 1596), n.p. (following "Praefatio").

<sup>20</sup> (Denis Dodart ?), " A l'occasion de la figure de Camerarius je repete ce que j'ay dit autre fois qu'il est absolument necessaire avant que de travailler a quelque description que ce soit d'une plante déia décrite et figurée de voir le plus qu'on pourra de descriptions et de figures. " " Aconitum salutiferum sive Anthora Aconit salutaire ou Anthora, " MS 450, Muséum national d'Histoire naturelle, Paris. The syntheses achieved by the *Histoire des plantes* depended on such comparisons, corrections, and repetitions. The final product, description and figure, ideally extracted the essential traits of the plant, depicted its principal parts in all stages of development, portrayed it as close to life-size as folio format permitted, and offered magnified views of details and

		March			6,	12,	9.
Weather	Winds.	Clouds.	Baror			Rain	-
Fair	1		1		-		
Sleet	N by E 2	75.5	29.	26	86	0.	12
	N by W3		<u> </u>	40		1	-
rair				64	80	0.	04
HirdFro.	NWb.No		1	72			
Fair	WI			77	96		
Cloudy	W by S 1	NW	1	78	96		
Cloudy	N by W2	NNE	2.	82	93	1	
Rain	N 2			91			
	N 2		30.	02	90	0.	02
Froft	NWO	N	1	11	79		
Cloudy	N by E 1	N by W		15			
Fairer	N by Wo		1	19			
Hard Fro.	NNWO		1	11			
	Eı	N by E		07			
Cloudy	SbyEo		29.	95			
and the second sec	SEI	S by E		82			
	SE by S2	SE			107		
Cloudy	0 L 0 y 0 2			88	89	ľ	
	ECE	VIEL T					
Fair	ESEO	NE by E	20	97	82		
1.411	E by N 2		30.	05	85		
Froft	NEO			12	80		
	ENE2		÷ .	13			
Cloudy				14	87	1	
	Mhu E	P				·	
	N by E c	ድ		10	85		
Cioudy	N by E 1			08	103		
Small	E L. M				91		_
	EbyNo			00	86		
1(411	S by W 2	S	29.		102		1
				93	92	-	11
	S 1			84	93	0.	18
Cloudy	S by W 1			84	106		
				78	97		
Rain	S by W I			63	93	0. 0	I
	S by E I			58	102		
Fairer				63 58 69	88	I. (	58
	Wo			80	81		-
Fair			611				
Cloudy				0,	108		

Fig. 15. Table for March 1697, William Derham, "Register of the Weather, etc. for the Year 1697," Philosophical Transactions 20(1698): 45-8.

State of the second second			wnley	La Halle Lab	Rain at <u>Appnington</u> in the years					
April . 10 April . 10 March 1 April . 10 May . 4 July . 16 Angust 19 Septim 10 October 19 Novend 19 Decend 10 Total 190	32.70 7:92 0:47 4:00 0:37 6:53 9:77 6:53 8:90 8:59 8:59 1 6:55 1 2 6:51 2	17 00 10 0 10 0 119 0 12 7 0 18 0 17 0 13 0 13 0 13 0 15 0 26 0 46 3 0 9 26 0 46 3 0 9 26 0 45 3 0 9 26 0 45 3 0 9 26 0 45 15 0 15	1701: 22.41 10.76 7.10 6.11 19.67 11.34 17.678 23.66 21.30 24.59 25.60 10.19 20.633	1099. 8 (9) 6 (05 5 (63 3 (44 2 (67 4 (40 6 (63 8 (97 8 (06 13 (49) 1 (93 5 (77 75:55	1700 3 (91 7 (64 1 (55 7 (60 6 (91 7 (60 4 (24 8 (14 14 (85 17 (15 5 (24 10 (30 95 (13)	417.01: 14 96 8 76 3 91 1 43 9 11 5 79 9 49 6 57 5 63 10 21 8 22 9 3 45				

Fig. 16. Rainfall at Townley and Upminster (1699-1701), William Derham to John Houghton, 5 April 1703, Early Letters D1/52, Royal Society, London. © The Royal Society.

dissections. The precondition for this verbal and visual composite observation was the prior tutelage of the senses that discerned, the hand that drew, and the mind that judged and described. Dodart achieved the combination of observations by a training process that resembled the apprenticeship of artisans.

Now let us return to the second example, the weather table. On 7 October 1663 Robert Hooke read a proposal to the Royal Society of London "(f) or the making of a more accurate history of the change of the weather ... ". Observers were not only told what to look at (the winds, heat and cold, the "colour and face of the sky" and how (e.g. assessing moisture with "a good hygroscope"); they were also instructed on how to register and display their observations. In order to lay hold of "this Proteus", the ever-changing weather, observers should "have a large book in folio ruld into severall columns, and each of these columns to be markd overhead wth the name of w<sup>t</sup> particulars are to be registered...". Hooke's memo<sup>21</sup> does not include a template illustration, but presumably the tables sent in from the Royal Society's most faithful weather watcher, Anglican divine and F.R.S. William Derham of Upminster in Essex followed up on Hooke's instructions. (Fig. 15) From such a table, Hooke explained, "one may be able at one view as it were to see all of the Schem or platforme of the weather for a whole month...".<sup>22</sup>

The aim of a natural history of weather was to be able to predict the future on the basis of observations of the past. Although some early modern observers hazarded causal explanations of why, for example, the barometer rose in foggy weather<sup>23</sup>, most followed Derham's lead in leaving such speculations to others.<sup>24</sup> The table of weather observations was used not only for the taking and keeping of data; it also was understood as a method of discovery of such correlations: between barometer readings and impending storms; between hot and cold spells and the incidence of distempers; between winds and the inclination of the magnetic needle. Since the early nineteenth century such relationships have been depicted as graphs; since the early twentieth century, as statistical correlations. But in the late seventeenth and early eighteenth centuries, tables were the preferred visual tool for discerning and testing possible connections between the weather and everything from the phases of the moon to the eruptions of Vesuvius.

Tables could also potentially draw together phenomena scattered across space as well as time. Seventeenth-century observers were dimly aware of weather patterns at a continental or even global scale (as in the case of Halley's 1686 map of the worldwide system of winds<sup>25</sup>). After comparing the temperatures at Zurich, and Upminster, Derham concluded that England got Zurich's weather after a few days' delay.<sup>26</sup> Derham's friend and fellow-observer Richard

- <sup>24</sup> "Whether the Observations my Register is filled with, will be of any use, to judge of the Fertility, or Scarcity, the Healthiness, or Diseases, or any other occurrences of the last, or of former, or future years, I shall leave to the much better judgments of You & the rest of the learned Members of your Hon<sup>ble</sup> Society. " William Derham to Hans Sloane, 23 January 1699/1700, Royal Society Archives, Early Letters/D1/49; printed in *Philosophical Transactions* 22(1700-1): 527-529.
- <sup>25</sup> Edmond Halley, "An Historical Account of the Trade Winds, and Monsoons, observable in the Seas between and near the Tropicks," *Philosophical Transactions* 16(1686-92): 153-168.
- <sup>26</sup> W. Derham, J.J. Scheuchzer, and Michel Angelo Tilli, "Tables of the Barometrical Altitude at Zurich in Switzerland in the Year 1708", *Philosophical Transactions* 26 (1708-9): 334-336, on p. 345.

<sup>&</sup>lt;sup>21</sup> See Thomas Sprat, *History of the Royal Society* (London: J. Martyn, 1667), pp. 173-179.

<sup>&</sup>lt;sup>22</sup> Robert Hooke, "For the making a more accurate history of the changes of weather ...," (1663), Royal Society of London Archives, Classified Papers, v. 20 (Hooke Papers), Nr. 24.

<sup>&</sup>lt;sup>23</sup> John Wallis, "Observations Continued upon the Barometer, or rather Balance of the Air..." *Philosophical Transactions* 1(1665-66): 163-166.

Aº 1739	Marti	is			and the second second
Alt.Ba	r. Alt.Therr	M. Ab. V. M	luvia	Declinatio	æli Conftitutio
M.M.	V. M. M. W.	M. 96. V. M	. M. V.	Magnetis M. M. V.	M. M. V.
1 0,92 0,92	19 19 52 19	RW RW, RW,	1	13 40 13 45 18 90 /	ran prend promb
2 28.9 28,92		W1 W1 W1 2		13 45 13 45 13 45 /	ren premo plura
3 282- 28,9	8, 11 97 97 92	WI NW, NW 8:	2 92 10		lura pren puetenbit
4 29 29,1	<u>*32 93 99 91</u>	ZW 20 2	1.	13 45 15 45 13 45 /2	en mubil: Mubilian
5 29,9 29,9	81 19 19 19	WWW			ron pren: prembe
6 29,9 39,9	2,9 96 19 96	W W W.I	10 1 10 20		elle pran: pramt.
7 29,3 29,3		W W. NW		13 90 13 90 13 90 50	ren: pron: promo
8 29/2 29,21		and available international statements in the		13 40 13 45 13 95 Je	ren Geren Sereman
9 29 28,102	And a second second second second	Wez W.g W.3		13 40 13 40 13 45 L	but prilan preme
10 28,9 5 28,10 2	AND I DOLLARD BUILDING COMPANY	WINLY N W		13 45 13 40 13 40 /1	en prena prenat
11 20 1 20,52 2 12 39.12 39.2 1		NO, NO NO 29			taine plaine premit
13 29.3 29.3 1		0 0 10 29	*	13 40 13 45 13 40 Je	ren Seren Brenn
14 29,3 29,3		NO NO NO		13 40 13 40 13 40 50	ren Lubrah Person
15 292 19,1 1	15 42 49 44	W X X W ZW, ZW			nen pran: pranne
16 20, 20, 20, 3		W. W. Mr			ren Rubelon Muchilian
	8 43 47 47 43 8 4 99 99 43		3	13 40 13 45 13 45 /	en plevia Seven en premi Sitruto do
1820.02 2002	P.9 45 50 45	Xul Xut X	4 30		
19 20,9 20,0 2		W. W. W. 30	1 31-3		rean mathin plura
20 28,7 20,62		W3 W3 W1,4 3	No. 1 December 201 Accession 4		
21 28,5 28,5 2	1.7 93 49 30	NIL XIV NW	33-	13 40 13 40 13 40 724	En mand Bornet prestas
22 28,7 28,7 2	P.0 42 44 37	N. N. NO 33		13 ac 12° at 2 00 he	and mibil Internal
23 20,9 20,9 2	19 37 99 39		11	13° an 13° an 13° as 17	and mobel Subrus
	92 39 49 30		198 181	13 40 13 40 13 ad Je	ren nubilin nubilin
	1,3 41 44 42		342	13° 10 13° 40 /m	and promet plan
26 20,2 20,2 2		NO 0 20.4	30	13 45 13 45 19:0 74	che mubil meant
27 27,6; 27,6 2		2 203 2014 40	40 1 49 2	13°55 13°55 13° AO /m	Al Mubel promoto for fay
28 27,7 27,9 2	8 1 40 39 36	N.2 NO N 40	5	13 35 13 40 13 40 /1	Rn: plurs nubilian 17
29 20,2 20,2 2	13 36 40 35	W. W.3 W.1	4	13 35 13 40 13 45 71.	and mubil: Brand
30 20,2 20,1 7	0 35 36 30	20. 0.2 2	472 49	1925 1925 1920 M	nen: firent promo
31 28,3 21,42 2	1,6 92 99 36	211 210 210		14 15 13 55 13 55 /	In: pran: Rosem
B. Que	a Range	C	2		
the	to'm const	logist and	Cart	gud d	ie 29 filit, per
D'	the	and gat	and c	amnas si	Ande mberrimas
Sur perot	andes; ex!	· R /	t.	nertim co	lum, aque insplaga
merio ma	quan	Depton :01	to	; everna	non minori
the qua	n cund a	and and	Sala	in calls	"Extentrionali"
plaga a	ant alve	interrip	ague .	nucles, sup.	na quas Linx can
Odidior er				0	Carlo and Andrews
monsis 4	ie fuit a	modum pl	uniofus	: hine me.	nia arva prataque
sub aqui	tecta lat	Bant; dilu	ni ax!	alentia for	mam 's

Fig. 17. Pieter van Musschenbroek, "Ephemerides meteorologicae leydenses annorum 1739 et 1740", Dossier Musschenbroek, Archives of the Académie des Sciences, Paris. ©Académie des Sciences – Institut de France, Paris.

Towneley of Lancastershire concluded from a comparison of weather tables that the barometer rose and fell all over Britain in unison.<sup>27</sup> (Fig. 16)

Using tables to see through time, correlating past and present, and space, correlating near and far, depended crucially on visual skills: how to construct, display, and read tables so that subtle connections leapt to the eye? Every column in the weather tables was at once a record of observation and a hypothesis to be tested. Pieter van Musschenbroek, professor first at Utrecht and then at Leiden and perhaps the most diligent of the meteorological correspondents of both the Royal Society and the Paris Académie, constructed his tables with columns for barometer, thermometer, winds, rainfall, constitution of the sky - and magnetic declination. (Fig. 17) The latter was conjectural: did the wild swings of the needle of the magnetic compass bear any relationship to the similarly erratic changes in wind direction or air pressure? In a 1729 letter to the Royal Society, Musschenbroek admitted that, so far, neither wind nor "have fair Weather, Rain, Snow or Storms any effect on the magnetical Virtue: whereof look into the Table, & you'l be confirm'd."28 Yet who knew how many years of observation would be needed to discern some subtle correlation among the entries in the columns? Musschenbroek did not lose hope in his magnetic observations, as his table submitted to the Paris Académie a decade later shows.

If the eye was to be able to survey the entire table at a glance, however, limits had to be set to complexity and sprawl. Such visual constraints also pushed table-makers to develop abbreviations and still more compact symbols, though standardizing these proved just as difficult as standardizing any other aspect of weather observation, from instruments to format to number and content of columns. Musschenbroek thought his elaborate symbols would be "at first sight easily underst(ood)" but nonetheless provided a legend. (Fig. 18) Despite Musschenbroek's optimism concerning the intelligibility of his symbols, the density and heterogeneity of these ingeniously con-

structed tables must have baffled the eye: how to make sense of the rows and columns of numbers, words, and symbols in one sweeping, panoramic glance, as Hooke and so many other early modern naturalists yearned to do?

<sup>&</sup>lt;sup>27</sup> R. Towneley, "An Account of What Rain at Townly in Lancashire, in the Years 1697 and 1698, with Some Other Observations on the Weather", *Philosophical Transactions* 21(1699): 47-48.

Pieter van Musschenbroek, "Meteorological, Barometrical, Thermometrical, Epidemical, and Magnetical Ephemerides written at Utrecht ... in the Year 1729 ", Royal Society, Classified Papers, IV(2)/6.

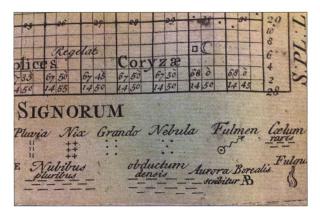


Fig. 18. Pieter van Musschenbroek, Detail of "Explicatio Signorum", "Meteorological ... Ephemerides" (1729), Classified Papers IV.2/6, Royal Society, London. © The Royal Society.

Weather tables could be read in right-angle fashion, by scanning down the leftmost column for a date and then moving rightwards along that row to ascertain the thermometer, barometer, or hygroscope measurements for that day. But tables could also be be surveyed in *coup d'oeil* fashion, like a landscape viewed from a hilltop, so that regularities invisible at valleylevel (or buried in single rows and columns) would snap into focus. In other words, the tables could be scanned like an image, not just read like a text. Ideally, a correlation, a periodicity, or some other pattern would crystallize visually, in the way that the thousands of multi-colored dots that compose a pointillist painting coalesce into a composition when viewed from the right distance. Whether these correlations would be between today's weather in Zurich and the day-after-tomorrow's weather in Upminster,

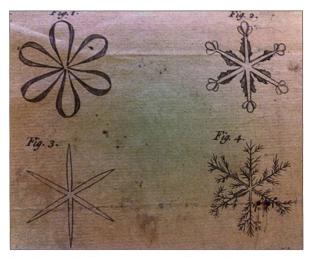


Fig. 19. Detail of "rosaceous, stellated" snowflakes observed under a microscope, "Meteorological ... Ephemerides" (1729), Classified Papers IV.2/6, Royal Society, London. © The Royal Society.

or between the new moon and low barometer readings, or between magnetic declination and the prevailing winds was all a matter of conjecture. Anything and everything might be relevant. The super-vision to which the weather-watchers aspired embraced time and space at the scale of generations and continents, but the actual visual skills required to achieve it were those of surveying a table compressed into a single page.

The fate of Musschenbroek's tables at both the Royal Society and the Paris Académie provides some insight into the challenges posed by this kind of seeing and how they were met. Of all the late seventeenth and early eighteenth-century weather tables printed in the annals of the London and Parisian scientific societies or preserved in their archives, Musschenbroek's are among the most elaborate in terms of their construction and most compendious in terms of the number and variety of observations they contain. In contrast to Derham, who might leave off observing for weeks at a time as his travels and personal affairs dictated, Musschenbroek recorded his observations not just every day without exception but indeed three times a day, morning, noon, and night. As we have seen, he devised a whole hieroglyphics to represent data on everything from fog to thunder. He tracked the rise and fall of the barometer with a kind of proto-graph. Moreover, he included pages and pages of further observations that could not be shoehorned into his tables, like the unusual shape of snowflakes that fell on 6 January 1729 (Fig. 19).

Yet at both the Royal Society of London and the Paris Académie Royale des Sciences Musschenbroek's fantastically detailed observations and tables languished in the archives, never to see the light of print. The more jam-packed the table, the harder it was to survey like an image. Paradoxically, the effort devoted to compressing data into brief entries and symbols may actually have decreased rather than increased their visual intelligibility. Had all the weather-watchers adopted the same visual conventions, perhaps a form of tabular literacy might have developed. Modern eyes gratefully absorb the several attempts to present barometer fluctuations graphically, as in the case of the table sent to the Royal Society by the Dutch land surveyor Nicolaas Kruik (Fig. 20). But there is no evidence that early modern eyes found these displays perspicuous; at least such conventions seem to have been occasionally reinvented but not imitated. Tables rarely fulfilled Hooke's hopes of being grasped at a glance.

There were however exceptions. When Leibniz published his table of "binary arithmetic" in 1703, he included a table displaying Base 2 and Base 10 equiv-

#### ARCHIVES DES SCIENCES

Janmar.	. Vebuar.	בורסיבוות	malys	intoryo	- print	Juciu	- Amonite	ogetienne.	Cuceur	a Vourinto.	ל שרכחווף.
In PARTY T	A. 7. 4 Tr. 1. 4.	8 - 57 - 8	P. 7. 4 TT. Y. P.	A 4 + A	A		T. + 4 7 . 4. P.	P. T. YIT. T. T.	havit of	1	Travit ration .
- man		an Bar				des 1			*		
	C	20 35-48 2 2 (14) 71-68 20 305			11 .	- 10	1 5 7				1
	1	1.1.1	1 8 1 4		1 1 1 1	Set				2/	
		1 63	131	1 2 - 1	1 8	1752	- at 1	1 10		1	1 1
	2.)	( 2 >	6 2 1	12.	1 8/	1 3 1				11/	1
			0			- DA -		6.7		1	AND IN THE REAL PROPERTY AND INCOME.
mile an	1000	1 \$1	18	1752	100 4	771			1	C	113
	1 26	121	1 3 1	1/ 2 .		13	1-1-1	3 5	13/1	2 3 . 1	3
= the	1 2 2 2	1.4 . (	51	1 3 3	1:2	1 1 3 .	1 6-1-	4.+	1	1:31	51 5
		LAN BROWNELL IN LAND AND AND A					1-1-1		Manager & Manager and		1
1		1 1 2 2 3		1 - 2 - 1	1 4 4 +	1 3-	I TRACTOR STRUCTURE		5 *	the l	
1.84	C 2 1	1 / \$ } (	\$ 3	2 /	128 5	1 8	1	1 21	1	······································	
1 8-	14	1/ 3/	1 2 5 1		1 = 2	100 2 0		1 .2 (		181	1
Contractor and a second second second second					1	- fee				1	
	Cat and	1 2 3	1 3 2	1 22 -		1 - 5 4					*
		( 8	1 8 1	83	1 2 2 1	1 2	87		Sal		81 8
	1253	2 815	\$13	\$) =			2)				j=3
A REAL PROPERTY OF A REAL PROPER	AL		1	- Li li li				1 1 /		1	
2 2 3	*** /	2 ? I	* 3	82		174	1 .	* /			~ 4   E
	mk? h	5.1	.**	6-	1	. 7-8-9	1 6 1			13	4 4
	7.3			1		3000-1	1/	· · · · ·		z senten decisi q Senten decisi q	
			101		1	11	1 1	1 1 )		1 1	
3/2	4	5 5 4	2 .	1 50	* *	1.8	*-	1 1 1	5	1 4 1	1 1 1
1 Strange		1 = 2	\$-	*.	1 + 1		7000	1 1 + 1			
	100	/					11-1-1			13.	1.
291		1 43	1 41		1 . * 5		1 9 1	1 2 2	1	G.	an F
2 -	1 ====		1 4 4 11	11.4	1 21		1 *	1 4	1	and D	100
	1 = 5	7:1	( + +	ing +		1.		1=	13-		CONTRACTOR AND THE PARTY OF A CONTRACTOR OF
S										1 1	
	34	7-21	11711	0	1	1/ 1	) * 1	1 / 9	(1	100	
Licon 2	1 4:	(87		1 9-	1 24	1 nº	1 91	0		1 21	NS
			1		1		11			States and American	
1871	11 10 -	1	90	1 1	- Aller	1 1	1 1				
1 1 12	1 43	11	38 7 3	14	1 5	1	131-	A.4	(-4·1	4 41	1 4 1 1 1 20
2 4 4 2	1 43	15 41	10	1 4 1	40 4	1	1 30	10-1	1	1 41	61
1 45	1			1	11		3			N	19
3 / 1		WI.	1 the	1	1/12						
2	1 1 +=	1 + 3	117:1	+ 3	**	11+-	( d+	1 + 1	+ 4	the second	- (+
2		01	1 1 - 11		- t -		1.00		with Ka	1 48	
-		112 4	1		1		1 20				
1	144		11 3		1 1		1-30-	9-	1 1	111	1
2 184 4	1.5-		1 + 3	11+	( + ;		N		11111/		
	38	3.8 · · · · · ·					18			9 - 6	Contraction / 2
Januar	. Fibricari	Martin	Aprilis	Majus	Janins		Augustin	September		November	Decemb.
and the state	1 de		a manufactor in	No and the	Julia martin	1			1 4 4 M	and the second second	

Fig. 20. Nicolaus Cruquius, "Observationes ... Lugduni Batavorum", Classified Papers 5/19, Royal Society, London. © The Royal Society.

alents, to be read in the usual right-angle fashion. (Fig. 21) However, Leibniz also instructed readers scan his table more holistically, in order to discover a property of geometric progressions: "One sees here at a glance (*d'un coup d'oeil*) the reason for a *celebrated property of the double (i.e. squared) geometric progression* of whole numbers ...". Leibniz did not recommend switching to Base 2 arithmetic, since the numbers would be longer and therefore more cumbersome than their Base 10 equivalents. Binary arithmetic, as set forth in his table, was rather a method of "new discoveries" in mathematics – for example of periodicities (e.g. of squares and cubes) in the columns, which Leibniz had carefully set off by inserting zeroes to "fill up the blank spaces" in his table.<sup>29</sup> Even a mathematical table could be read in *coup d'oeil* fashion, in search of cycles and correlations, just as Hooke had hoped to read the weather tables.

## IV. Conclusion : Prelapsarian Vision

This was not the first time that Leibniz had tried to visualize heaps of data by seeing them all in one view. At about the same time as Hooke was instructing Royal Society weather watchers, Leibniz wrote a memo to an unnamed prince proposing a "Table of the State (*Staatstafel*)" that would digest all the information gathered in the royal archives into a onepage synopsis that would make everything "easy to find but also what belongs together visible in a

<sup>&</sup>lt;sup>29</sup> Gottfried Wilhelm Leibniz, "Explication de l'arithmétique binaire, qui se sert des seuls caracteres 0 & 1, avec les Remarques sur son utilité, & sur ce qu'elle donne le sens des anciennes figures Chinoises de Fohy", Mémoires de l'Académie Royale des Sciences. Année 1703 (Paris: Chez Jean Boudot, 1705), pp. 85-89, on pp. 85-86.

···
- MACADEMIE ROYALD
TABLE 86 MEMOIRES DE L'ACADEMIE ROYALE
NOMBRES. plus haut degré. Car icy, c'eft com- 10 2
NOMBRES plus haut degré. Car icy, cen comi in in addition me fi on difoir, par exemple, que in in iddition de fi on difoir, par exemple, que in in iddition de deux in in the second de deux in in the second de deux in
ou 7 eft la fomme de quatre, de deux 111 17 & d'un ou 7 eft la fomme de quatre, de huit, quatre 1000 11
e de la comme de quarte, de la forme de huit, quarre room la comme de la comme de huit, quarre room la comme de la comme
Et que Itoi ou 13 eff la forma ux Effayeurs pour & un. Cette proprieté fert aux Effayeurs pour & un. Cette proprieté fert aux Effayeurs pour
ereito 6 certe armellon des Nombres étant établie, fert à
faire tres facilement toutes fortes d'operations.
110 6 101 5 1110 14
Pour l'Addition III 7 IOII II 10001 17
101111 par exemple. 1101 13 10000 16 11111 31
I TA OUT
Dave la Car Inointi 1000000 10 1111151
the first fratter the first total in 18001 if
• 1111 14 Frattier. 110 6 101 5 1110 14
10000 16 1 1 1 1 101 5 101 5
1000117 Pour la Mul- 11 3 11 3 101 5
PIODICIS tiplication, II IOI IOI
· 1001 10 101 101 1010
21 10011 21 1111 9 1001 2
11 10101
10110 22 Pour la Division. 15 2211 101
·11000 24
"I 1001 25 Et toures ces operations sont si aisces, qu'on n'a jamas
"II 0 I C 16 befoin de rien effayer ni deviner, comme il faut faire
"II 0 1 1 27 dans la division order ni deviner, comme il faut fant "II 0 2 28 de rien apprendre nearent On n'a point befoin non-plas
toooc 12 pelle Pythagorique. Mais icy tout cela le trouve & to
cedens fous les fignes D & O.

Fig. 21. Gottfried Wilhelm Leibniz, " Explication de l'arithmétique binaire …", Mémoires de l'Académie Royale des sciences. Année 1703 (Paris, 1705): 85-89.

glance," without having to depend on memory.<sup>32</sup> Bacon also recommended the making of "tables"(by which he meant ordered lists) because "natural and experimental history is so various and diffuse that it distracts and confounds the understanding."<sup>33</sup> Wherever memory buckled under an unbearable load of information, the longing to see everything all at once was resurgent.

The faculty that came to the aid of over-worked memory was called "intuition", a faculty associated since the thirteenth century with the cognition of angels in the works of Bonaventure and Thomas Aquinas.<sup>34</sup> Just what intuition was and how it worked was a matter upon which learned opinions diverged, but almost all commentators were agreed that it was lightning fast, dazzlingly clear, and indubitably certain. Memory had been the faculty cultivated by Renaissance humanists, who were fond of pointing out that Mnemosyne, the goddess of memory, was the mother of the muses in Greek mythology. But by the mid-

*moment.*<sup>"30</sup> Like so many of Leibniz's brilliant and wacky projects, this one was never realized.<sup>31</sup> But one catches echoes of the ambition to see everything all at once in the most unexpected places among the annals of early modern science and philosophy. Descartes, for example, fretted about how the long deductions in mathematical demonstrations made such arguments no better than mere enumerations. Real certainty could be obtained only when the mind could grasp the proof as a whole, "take(n) in at one

<sup>30</sup> "Alles aber nicht allein leicht zu finden, sondern auch was zusammengehört, gleichsam in einem Augenblick zu übersehen..." Gottfried Wilhelm Leibniz, "Entwurf gewisser Staatstafeln, " in Mohammed Rassen and Justin Stagl, eds., Geschichte der Staatsbeschreibung. Ausgewählte Quellentexte 1456-1813 (Berlin: Akademie Verlag, 1994), pp. 319-329, on p. 325. On Baroque tables of the sort Leibniz might have had in mind, see Cornelia Vissmann, Akten: Medientechnik und Recht (Frankfurt am Main: Fischer, 2001), pp. 204-217. seventeenth century, even the most titanic memory could no longer keep up with the avalanche of printed books tumbling from the printing press or the flood of observations being sent from all over the world to sci-

<sup>&</sup>lt;sup>11</sup> Matthew L. Jones, *The Good Life in The Scientific Revolution : Descartes, Pascal, Leibniz, and the Cultivation of Virtue* (Chicago : University of Chicago Press, 2006), p. 240, describes Leibniz's fascination with tables in many contexts.

<sup>&</sup>lt;sup>2</sup> René Descartes, Rules for the Direction of the Mind (comp. 1628), in John Cottingham, Robert Stoothoff, and Dugald Murdoc, trans., The Philosophical Writings of Descartes, 2 vols. (Cambridge: Cambridge University Press, 1985), vol. 1, Rule III, pp. 14-5; cp. Matthew L. Jones, The Good Life in The Scientific Revolution: Descartes, Pascal, Leibniz, and the Cultivation of Virtue (Chicago: University of Chicago Press, 2006), p. 27.

<sup>&</sup>lt;sup>33</sup> Francis Bacon, Novum organum (1620), Bk. II, Aphorisms X-XV.

<sup>&</sup>lt;sup>34</sup> David Keck, Angels and Angelology in the Middle Ages (Oxford: Oxford University Press, 1998).



Fig. 22. Model for Pavia Cathedral (1488- ca. 1507). Musei Civici del Castello Visconteo, Pavia. From: Ausstellungskatalog Architekturmodelle der Renaissance, Bernd Evert (ed.) (München, 1995): 226.

entific academies. In 1680, Leibniz cursed "that horrible mass of books that keeps on growing"<sup>35</sup>; the secretaries of the Royal Society and the Académie Royale des Sciences must have sometimes felt the same way about the observations stacked up in their archives. Bookish scholars invented compendia, indices, tables of contents, headings, and other devices to manage their information overflow, but the naturalists hoped that intuition would come to their rescue in the form of the synoptic image.

Like the orrery that contracted the solar system to a table-top toy or the architectural model that shrunk a cathedral to dollhouse size (Fig. 22), the synoptic image recaptured the swift, sure confidence of ordinary perception for extraordinary objects: the type of a plant species; the patterns of the weather.

<sup>&</sup>lt;sup>35</sup> Quoted in Ann M. Blair, Too Much to Know: Managing Scholarly Information before the Modern Age (New Haven: Yale University Press, 2010), p. 58.

However arduous the processes of making and integrating collective observations, its early practitioners hoped thereby to restore the scale and immediacy of everyday experience – but for objects that were scattered over continents and centuries, spread out in series, or pieced together from fragmentary reports. To describe their efforts as "data management" or "information processing" fails to capture the distinctly early modern yearnings for a prelapsarian or even angelic form of vision that knew by flashes of intuition, not by plodding discourse or long vigils of repeated observations: the longing to see everything, all at once, and all together in one synoptic image.