

was "quite regular," although, on later inspection, the photograph showed the splash to be anything but symmetrical.⁵ What had been a high-order scientific virtue — tracking and documenting the essential, ideal "Auto-Splash" — became a psychological fault, a defect in perception.

Now, in 1895, Worthington told his audience that the earlier images of perfect drops had to be discarded. In their place, he wanted images that depicted the physical world in its full-blown complexity, its asymmetrical individuality — in what he called, for short, "an objective view."⁶ Only this would provide knowledge of what he considered "real, as opposed to imaginary fluids."⁷

Worthington's conversion to the "objective view" is emblematic of a sea change in the observational sciences. Over the course of the nineteenth century other scientists, from astronomers probing the very large to bacteriologists peering at the very small, also began questioning their own traditions of idealizing representation in the preparation of their atlases and handbooks. What had been a supremely admirable aspiration for so long, the stripping away of the accidental to find the essential, became a scientific vice.

This book is about the creation of a new epistemic virtue — scientific objectivity — that drove scientists to rewrite and re-image the guides that divide nature into its fundamental objects. It is about the search for that new form of unprejudiced, unthinking, blind sight we call scientific objectivity.

Epistemologies of the Eye

Blind Sight

Scientific objectivity has a history. Objectivity has not always defined science. Nor is objectivity the same as truth or certainty, and it is younger than both. Objectivity preserves the artifact or variation that would have been erased in the name of truth; it scruples to filter out the noise that undermines certainty. To be objective is to aspire to knowledge that bears no trace of the knower — knowledge unmarked by prejudice or skill, fantasy or judgment, wishing or striving. Objectivity is blind sight, seeing without inference, interpretation, or intelligence. Only in the mid-nineteenth century did scientists begin to yearn for this blind sight, the "objective view" that embraces accidents and asymmetries, Arthur Worthington's shattered splash-coronet. This book is about how and why objectivity emerged as a new way of studying nature, and of being a scientist.

Since the nineteenth century, objectivity has had its prophets, philosophers, and preachers. But its specificity — and its strangeness — is most clearly seen in the everyday work of its practitioners: literally seen, in the essential practice of scientific image-making. Making pictures is not the only practice that has served scientific objectivity: an armamentarium of other techniques, including inference statistics, double-blind clinical trials, and self-registering instruments, have been enlisted to hold subjectivity at bay.¹ But none is as old and ubiquitous as image making. We have chosen to tell the history of scientific objectivity through pictures drawn from the long tradition of scientific atlases, those select collections of images that identify a discipline's most significant objects of inquiry.

Look, if you will, at these three images from scientific atlases: the

first, from an eighteenth-century flora; the second, from a late nineteenth-century catalogue of snowflakes; the third, from a mid-twentieth-century compendium of solar magnetograms (see figures 1.1, 1.2, and 1.3). A single glance reveals that the images were differently made: a copperplate engraving, a microphotograph, an instrument contour. The practiced eye contemporary with any one of these images made systematic sense of it. These three figures constitute a synopsis of our story. They capture more than a flower, a snowflake, a magnetic field: each encodes a technology of scientific sight implicating author, illustrator, production, and reader.

Each of these images is the product of a distinct code of epistemic virtue, codes that we shall call, in terms to be developed presently, truth-to-nature, mechanical objectivity, and trained judgment. As the dates of the images suggest, this is a historical series, and it will be one of the principal theses of this book that it is a series punctuated by novelty. There was a science of truth-to-nature before there was one of objectivity; trained judgment was, in turn, a reaction to objectivity. But this history is one of innovation and proliferation rather than monarchic succession. The emergence of objectivity as a new epistemic virtue in the mid-nineteenth century did not abolish truth-to-nature, any more than the turn to trained judgment in the early twentieth century eliminated objectivity. Instead of the analogy of a succession of political regimes or scientific theories, each triumphing on the ruins of its predecessor, imagine new stars winking into existence, not replacing old ones but changing the geography of the heavens.

There is a deep historical rhythm to this sequence: in some strong sense, each successive stage presupposes and builds upon, as well as reacts to, the earlier ones. Truth-to-nature was a precondition for mechanical objectivity, just as mechanical objectivity was a precondition for trained judgment. As the repertoire of epistemic virtues expands, each redefines the others. This is not some neat Hegelian arithmetic of thesis plus antithesis equals synthesis, but a far messier situation in which all the elements continue in play and in interaction with one another. Late twentieth-century scientists could and did still sometimes strive for truth-to-nature in their images, but they did not, could not, simply return to the ideals and practices of their eighteenth-century predecessors. The meaning of truth-to-nature had

been recast by the existence of alternatives, which in some cases figured as competitors. Judgment, for example, was understood differently before and after objectivity: what was once an act of practical reason became an intervention of subjectivity, whether defensively or defiantly exercised.

In contrast to the static tableaux of paradigms and epistemes, this is a history of dynamic fields, in which newly introduced bodies reconfigure and reshape those already present, and vice versa. The reactive logic of this sequence is productive. You can play an eighteenth-century clavichord at any time after the instrument's revival around 1900 — but you cannot hear it after two intervening centuries of the pianoforte in the way it was heard in 1700. Sequence weaves history into the warp and woof of the present: not just as a past process reaching its present state of rest — how things came to be as they are — but also as the source of tensions that keep the present in motion.

This book describes how these three epistemic virtues, truth-to-nature, objectivity, and trained judgment, infused the making of images in scientific atlases from roughly the early eighteenth to the mid-twentieth century, in Europe and North America. The purview of these virtues encompasses far more than images, and atlases by no means exhaust even the realm of scientific images.² We have narrowed our sights to images in scientific atlases, first, because we want to show how epistemic virtues permeate scientific practice as well as precept; second, because scientific atlases have been central to scientific practice across disciplines and periods; and third, because atlases set standards for how phenomena are to be seen and depicted. Scientific atlas images are images at work, and they have been at work for centuries in all the sciences of the eye, from anatomy to physics, from meteorology to embryology.

Collective Empiricism

All sciences must deal with the problem of selecting and constituting "working objects," as opposed to the too plentiful and too various natural objects. Working objects can be atlas images, type specimens, or laboratory processes — any manageable, communal representative of the sector of nature under investigation. No science can do without such standardized working objects, for unrefined natural objects



Fig. 1.1. Truth-to-Nature. *Campanula foliis hastatis dentatis*, Carolus Linnaeus, *Hortus Cliffortianus* (Amsterdam: n.p., 1737), table 8 (courtesy of Staats- und Universitätsbibliothek Göttingen). Drawn by Georg Dionysius Ehret, engraved by Jan Wandelaar, and based on close observation by both naturalist and artist, this illustration for a landmark botanical work (still used by taxonomists) aimed to portray the underlying type of the plant species, rather than any individual specimen. It is an image of the characteristic, the essential, the universal, the typical: truth-to-nature.

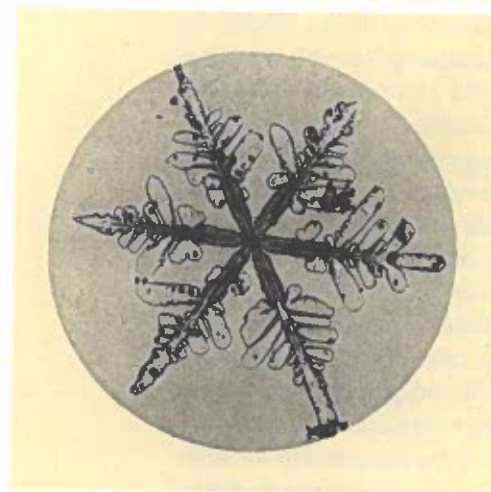


Fig. 1.2. Mechanical Objectivity. Snowflake, Gustav Hellmann, with microphotographs by Richard Neuhauss, *Schneekrystalle: Beobachtungen und Studien* (Berlin: Mückenberger, 1893), table 6, no. 10. An individual snowflake is shown with all its peculiarities and asymmetries in an attempt to capture nature with as little human intervention as possible: mechanical objectivity.

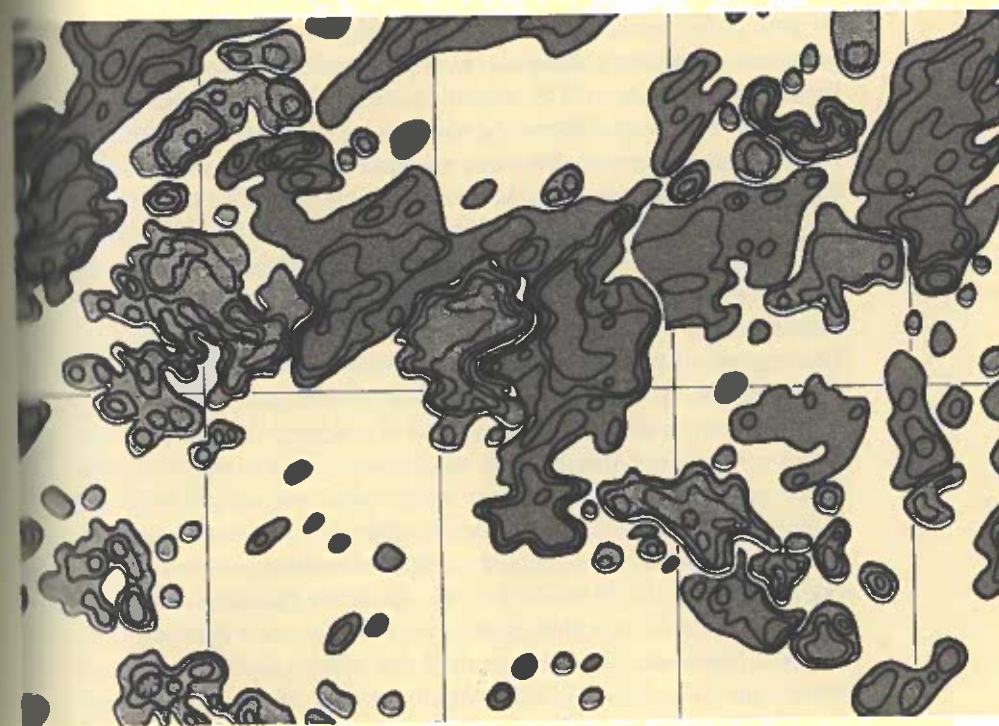


Fig. 1.3. Trained Judgment. Sun Rotation 1417, Aug.–Sept. 1959 (detail), Robert Howard, Václav Bumba, and Sara F. Smith, *Atlas of Solar Magnetic Fields*, August 1959–June 1966 (Washington, DC: Carnegie Institute, 1967) (courtesy of the Observatories of the Carnegie Institution of Washington, DC). This image of the magnetic field of the sun mixed the output of sophisticated equipment with a “subjective” smoothing of the data—the authors deemed this intervention necessary to remove instrumental artifacts: trained judgment. (Please see Color Plates.)