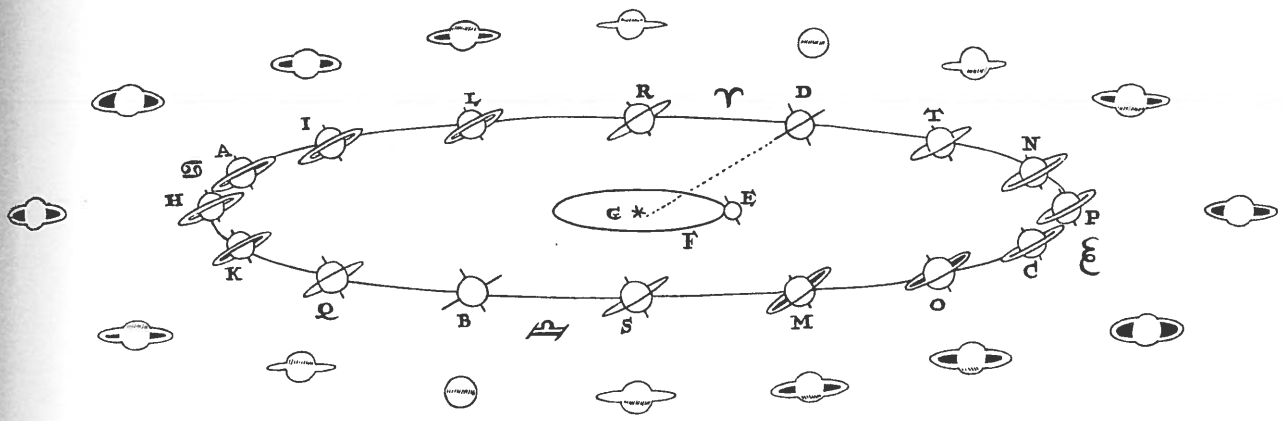
4 *Small Multiples*



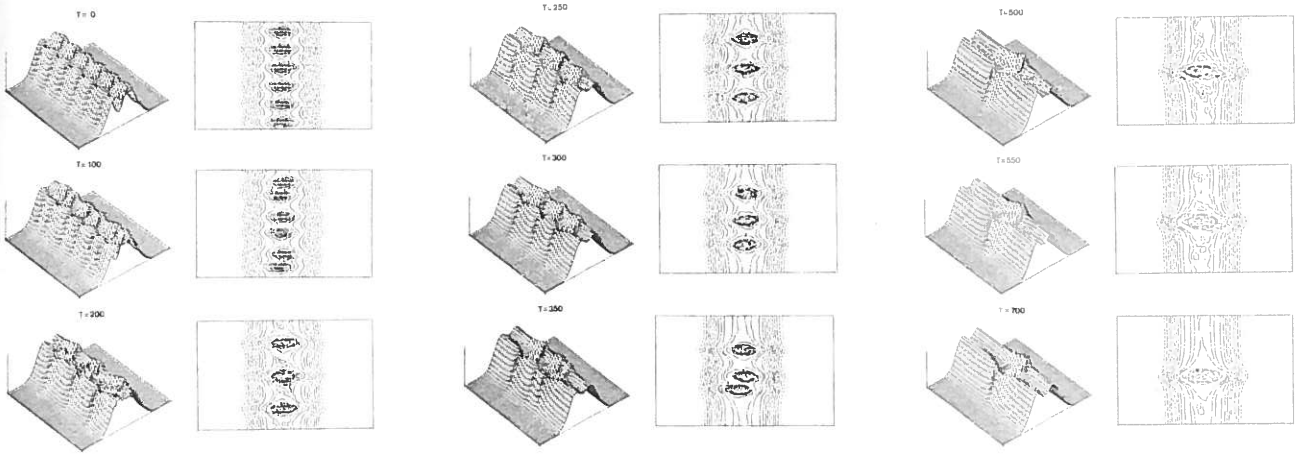
Christiaan Huygens, *Systema Saturnium* (The Hague, 1659), 55.

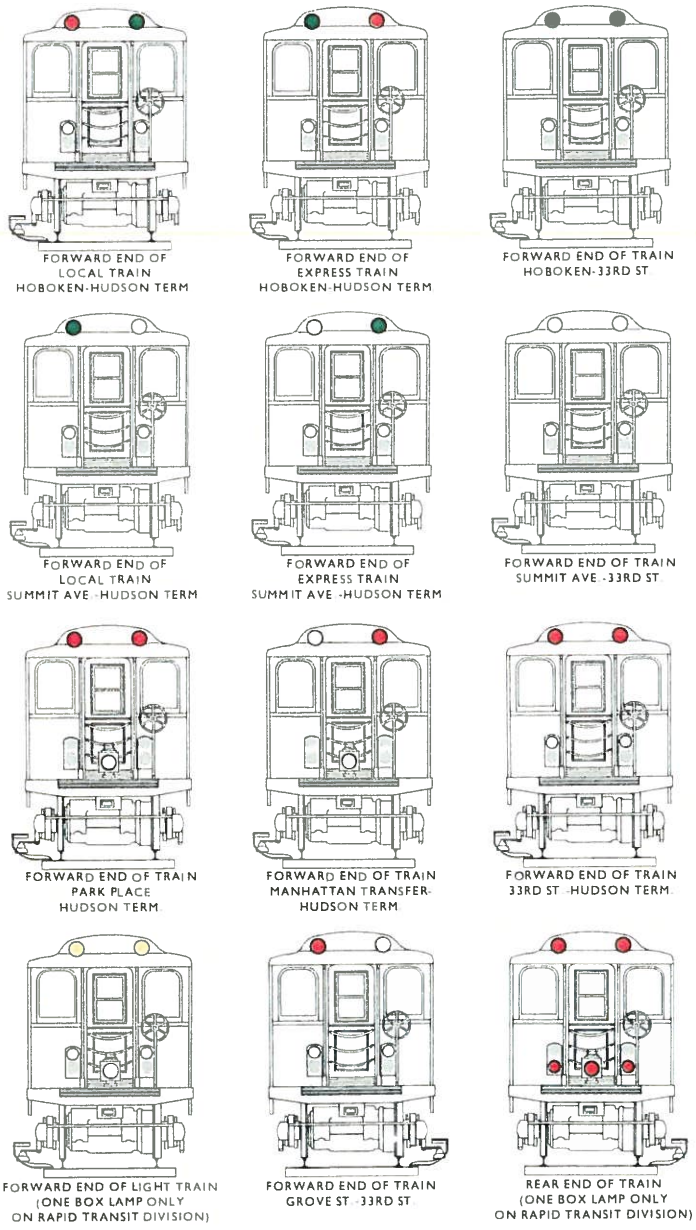
In this splendid 1659 drawing by Christiaan Huygens, the inner ellipse traces Earth's yearly journey around the Sun; the larger ellipse shows Saturn's orbit, viewed from the heavens. The outermost images depict Saturn as seen through telescopes located on Earth. All told, we have 32 Saturns, at different locations in three-space and from the perspective of two different observers—a superior *small multiple* design.

At the heart of quantitative reasoning is a single question: *Compared to what?* Small multiple designs, multivariate and data bountiful, answer directly by visually enforcing comparisons of changes, of the differences among objects, of the scope of alternatives. For a wide range of problems in data presentation, small multiples are the best design solution.

Illustrations of postage-stamp size are indexed by category or a label, sequenced over time like the frames of a movie, or ordered by a quantitative variable not used in the single image itself. Information slices are positioned within the eyespan, so that viewers make comparisons at a glance—uninterrupted visual reasoning. Constancy of design puts the emphasis on changes in data, not changes in data frames.

A. Ghizzo, B. Izrar, P. Betrand, E. Fijalkow, M. R. Feix, and M. Shoucri, "Stability of Bernstein-Greene-Kruskal Plasma Equilibria: Numerical Experiments Over a Long Time," *Physics of Fluids*, 31 (January 1988), 72-82. Viewing these illustrations upside down turns the mountains into valleys. Note also the two-space contour plots to the right of the three-space perspectives.

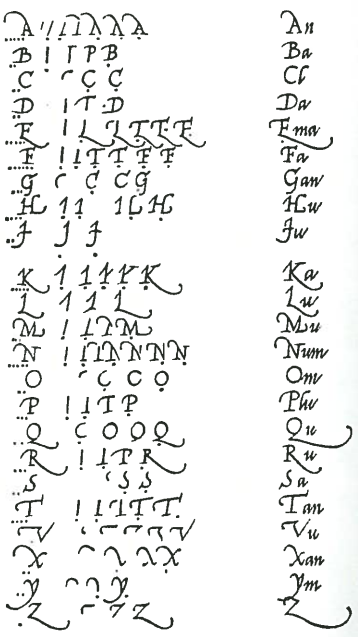




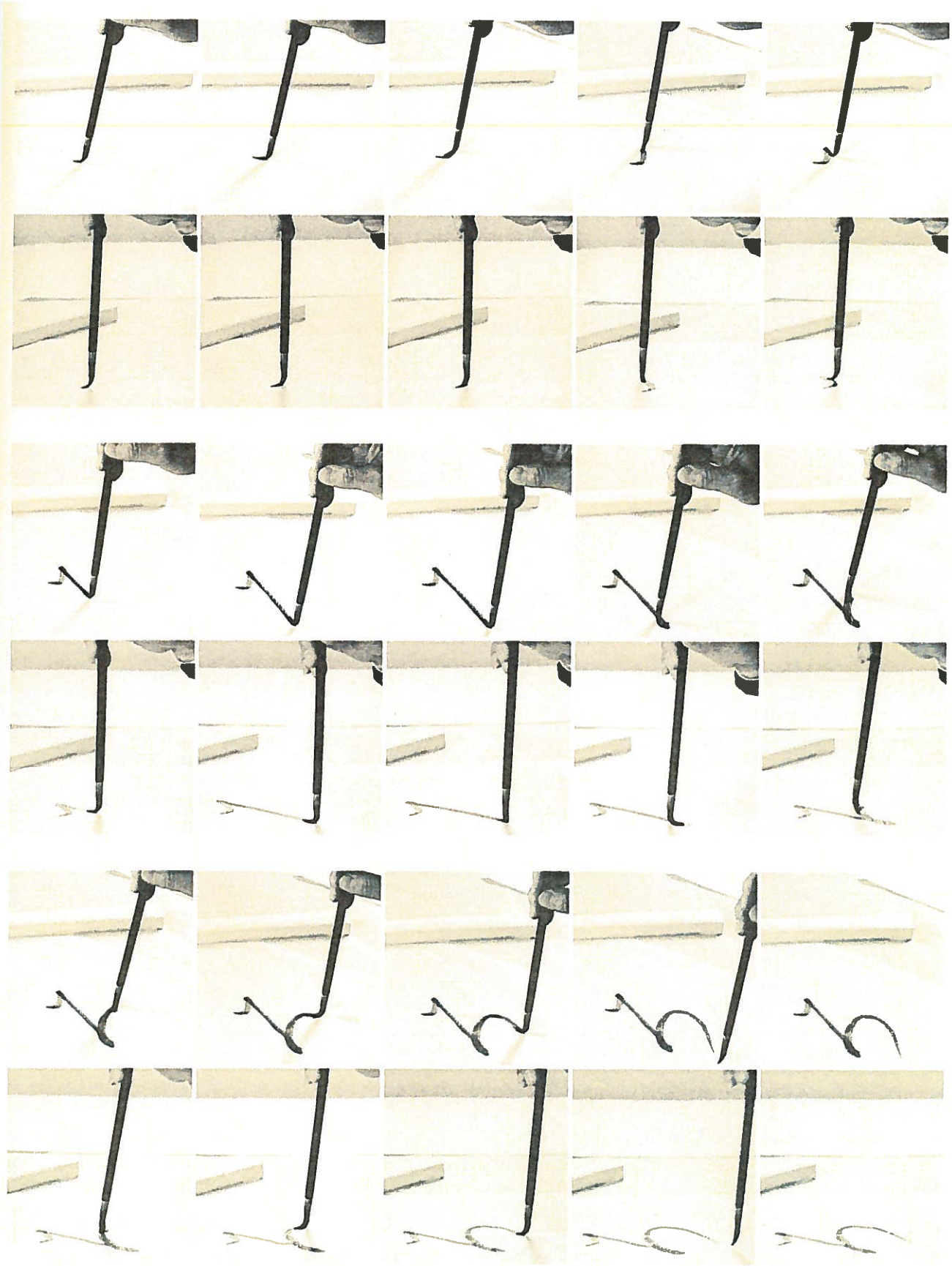
Rules and Regulations for the Government of Employees of the Operating Department of the Hudson & Manhattan Railroad Company, Effective October 1st, 1923 (New York, 1923), 21. Redrawn.

SMALL multiples reveal, all at once, a scope of alternatives, a range of options. Above, varying signal lights on the ends of a train are entabled in a rulebook for railroad employees. Our redrawing mutes the repeated train outline and brings forward differentiating colors.

At far right, these photographs capture pressure, direction, and speed of the calligraphic brush as it draws a single Kana character. Images are indexed by time (→) and by dual camera angle (↑). The paired series of photographs link hand, brush, and character (top row). The second row shows pressure and bend of the brush-tip—and the consequent width of line. The sequence has a magical quality, reflecting a remark of Garry Winograd, the photographer: "There is nothing as mysterious as a fact clearly described."



At right, Kayu Hirata, *Tsugi Shiki Shi*, volume 25 of *Shodo Giho Koza* [*Techniques in Calligraphy*] (Tokyo, 1974), 30. Above, without the aid of film, Mercator shows a similar sequence, the proper ordering of strokes in the formation of capital letters. Gerardus Mercator, *Literarum Latinarum, quas Italicas cursoriasque vocant, scribendarum ratio* [*The method of writing the Latin letters, which are called italic and cursive*] (Louvain, 1540), chapter 6.



MURAL WITH BLUE BRUSHSTROKE

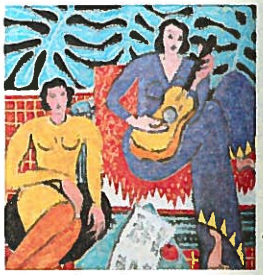
To make *Mural with Blue Brushstroke*, Lichtenstein drew on sources ranging from the most exalted to the most banal. Classical architecture (2, 14) provided inspiration, as did the site itself (8, where painted windows align with real ones). Homages to twentieth-century masters abound: Léger's people (1), Kelly's color fields (6), Matisse's split philodendron form (9), Arp's silhouettes (10, echoed in a piece of Swiss cheese), De Kooning's brushstrokes (12), Stella's triangles and French curves (15), Johns's flagstones (16), and Braque's balusters (20). Art styles—like Abstract Expressionism (11, 12, and 13, the latter with its "perfect painting"), Cubism (20), and Art Deco (21)—and artist's tools (4, 5, and 15) appear. And bustling around amid all this high culture are images of everyday modern life, those perennial sources of fascination to Lichtenstein: sunbursts (3), copy books (17), advertisements (7), food and drink (10, 18), and, of course, comic strips (19).

1. Detail of *The Dance* by Fernand Léger

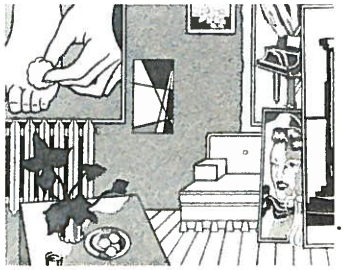
2. Facade, Library of Celsus, Ephesus

7. Ad for Elgin watches, 1950s

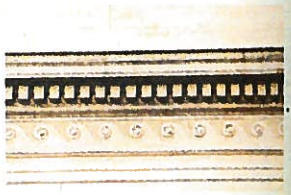
8. Detail of the mural in place at Equitable



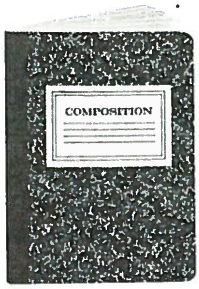
9. Henri Matisse, *Music*, 1939



13. Roy Lichtenstein, *Artist's Studio —Foot Medication*, 1974

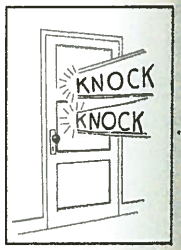


14. Entablature on downtown New York building



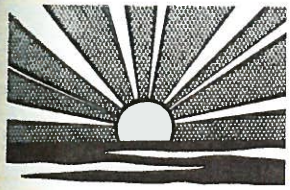
17. Classic black-and-white composition book

18. Roy Lichtenstein, *Still Life with Red Wine*, 1972



19. Roy Lichtenstein, *Knock Knock*, 1961

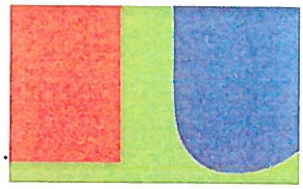
Roy Lichtenstein created "Mural with Blue Brushstroke" for the lobby of a building in New York. The large painting contains allusions to other works by Lichtenstein as well as many quotations (some a bit vaporous) from other artists. For a book describing the mural, Samuel



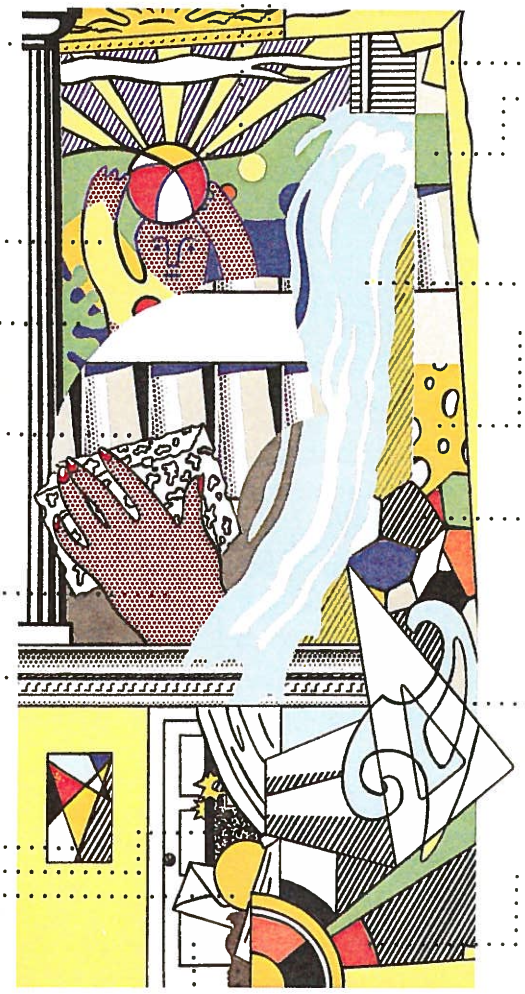
3. Roy Lichtenstein, *Placid Sea*, 1964

4. A gilded picture frame

5. The back of a painting, showing canvas, stretcher, and wedges



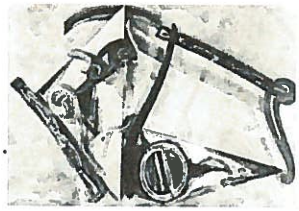
6. Ellsworth Kelly, *Red Blue Green*, 1963



10. Jean Arp, *Six White Forms and One Gray Form Make a Constellation on a Blue Ground*, 1953

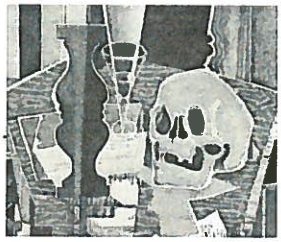
11. Roy Lichtenstein, *Big Painting*, 1965

12. Willem de Kooning, *Greece on 8th Avenue*, 1958

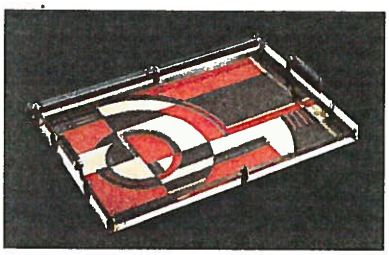


15. Frank Stella, *Dove of Tanna*, 1977

16. Jasper Johns, *End Paper*, 1976



20. Georges Braque, *The Baluster*, 1938

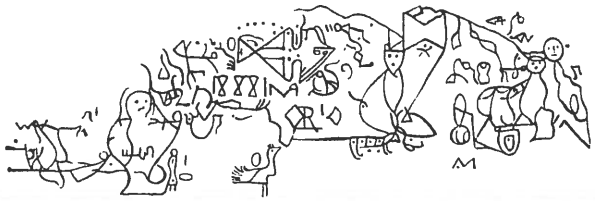


21. Art Deco tray, designer and manufacturer unknown

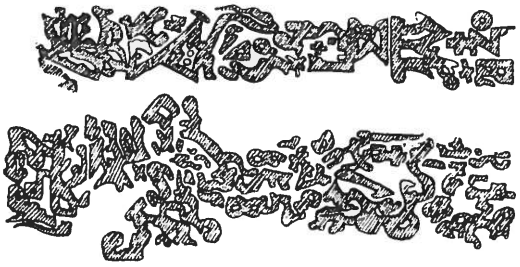
Antupit (who was also responsible for the annotated invoice from the hospital) crafted this superb double-page spread, linking 21 small images from various sources to the mural at center. This design both isolates detail and places it in context.

Roy Lichtenstein: Mural with Blue Brushstroke, essay by Calvin Tomkins, photographs and interview by Bob Adelman (New York, 1988), 30–31.

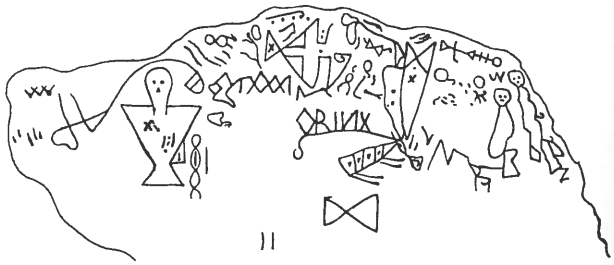
Danforth, 1680



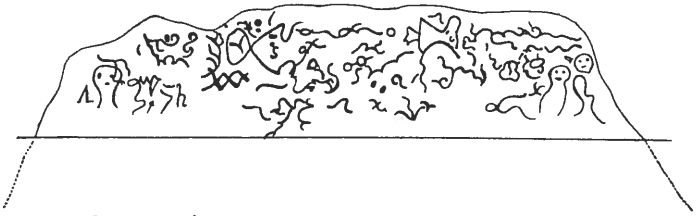
Baylies and Goodwin, 1790



Cotton Mather, 1712

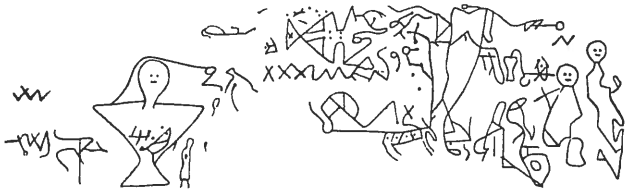


E. A. Kendall, 1807

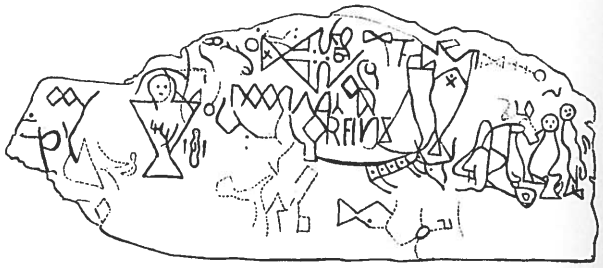


Isaac Greenwood, 1730

Job Gardner, 1812

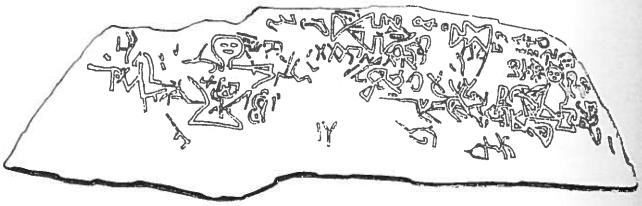


Stephen Sewell, 1768



Rhode Island Historical Society, 1830

James Winthrop, 1788



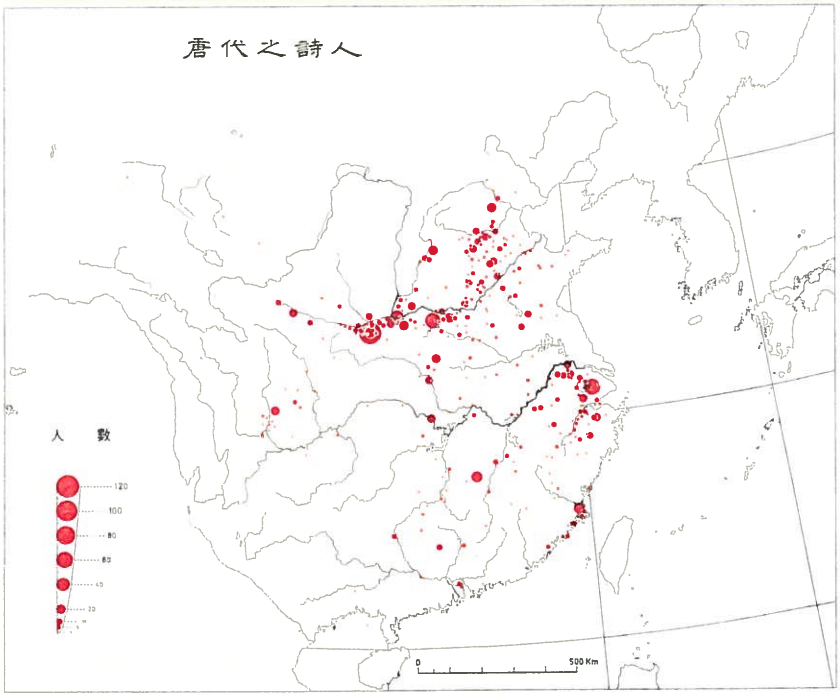
Henry R. Schoolcraft, 1854

With figures and pictographs chipped into stone, the Dighton Writing Rock sits near the Taunton River in southeastern Massachusetts. From 1680 onwards, observers sketched the inscriptions, with divergent results. Same rock, different views, arrayed here in a comparative small multiple. Some of these uncertain drawings, when sent off to European scholars, were then converted into far-reaching historical discoveries of startling visits to the New World. One researcher "triumphantly established" the marks as Scythian; a distinguished Orientalist detected the word *melek* (king) on the rock; others thought they saw Phoenician or Runic script. A Scandinavian antiquary translated the drawings into an account of a pre-Columbian sojourn to America by a party of Thorfinn the Hopeful. Since the writing resembles that on the Indian God Rock hundreds of miles southwest, such logic places the Vikings far inland, deep into what is now West Virginia and Ohio. All this scholarship of wishful thinking denies priority to the original Native-American residents; local experts conclude that the marks are Algonquin.[1]

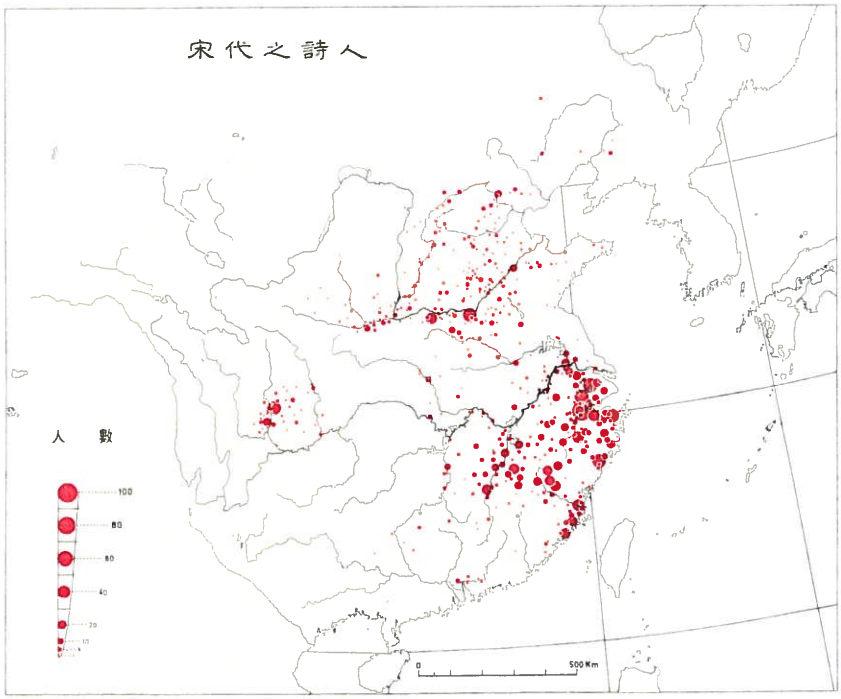
A focused small multiple, below, shows the history of variations in the ghost-like figure, enforcing comparisons over time (the ghosts even could be spaced in proportion to the date they were drawn):

[1] Charles Christian Rafn, *Antiquités Américaines d'après les Monuments Historiques des Islandais et des Anciens Scandinaves* (Copenhagen, 1845); Henry R. Schoolcraft, *Information Respecting the History, Condition, and Prospects of the Indian Tribes of the United States*, Part IV (Philadelphia, 1854), plate 14. Garrick Mallery, "Picture-Writing of the American Indians," in *Tenth Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1888-89* (Washington, DC, 1893), 762-764, and plate LIV; redrawn. John Michell, *Megalithomania* (Ithaca, New York, 1982), 145, on local expert opinion. Other instances of divergent interpretations of ambiguous visual signals include variable readings of the floor plan of San Carlo alle Quattro Fontane in Rome; see Rudolf Arnheim, *New Essays on the Psychology of Art* (Berkeley, 1986), 301-309; and Leo Steinberg, *Borromini's San Carlo alle Quattro Fontane* (New York, 1977). The melancholy history of the canals of Mars seen by Schiaparelli and Lowell is documented in William Sheehan, *Planets and Perception: Telescopic Views and Interpretations, 1609-1909* (Tuscon, Arizona, 1988).

DURING the last 1,260 years in China, where did poets flourish? How many poets? And have their birthplaces changed over the years? Four maps, based on an inherently imperfect historical record, address these prominent questions.



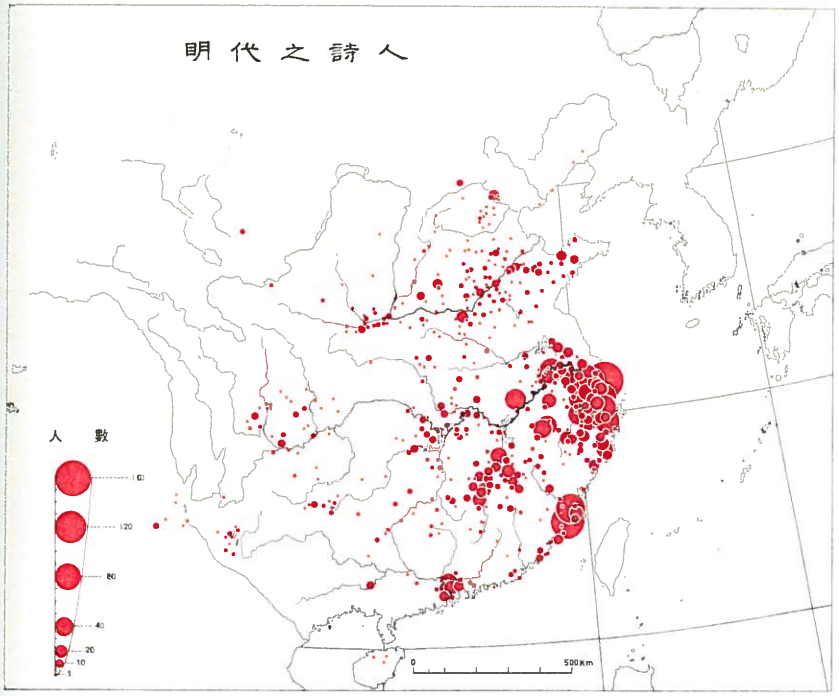
Birthplaces of the 2,625 Tang poets, 618–907



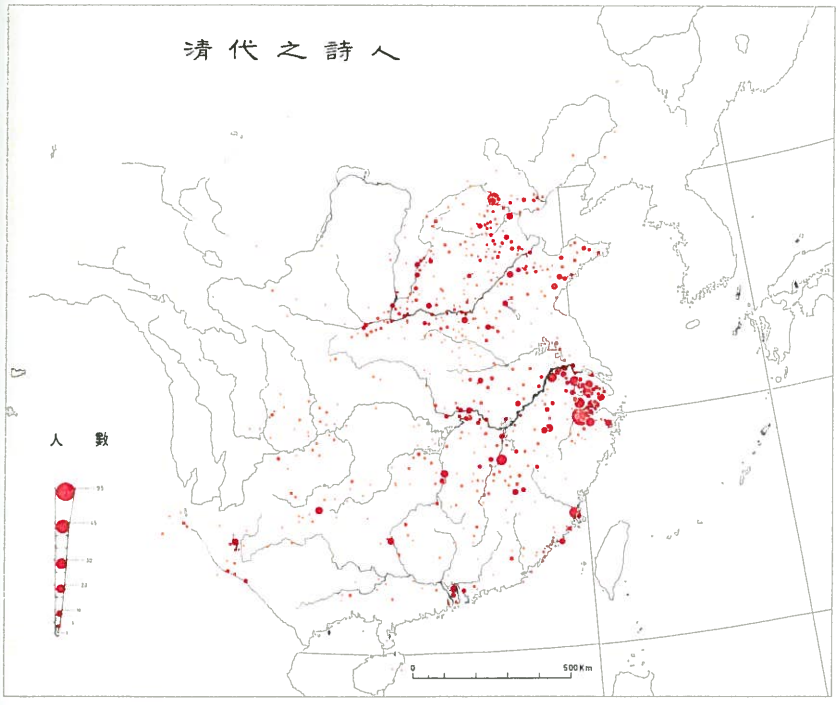
Birthplaces of the 2,377 Sung poets, 969–1279

Redrawn from Chen Cheng-Siang, *An Historical and Cultural Atlas of China* (Tokyo, 1981), maps 36, 50, 62, and 82.

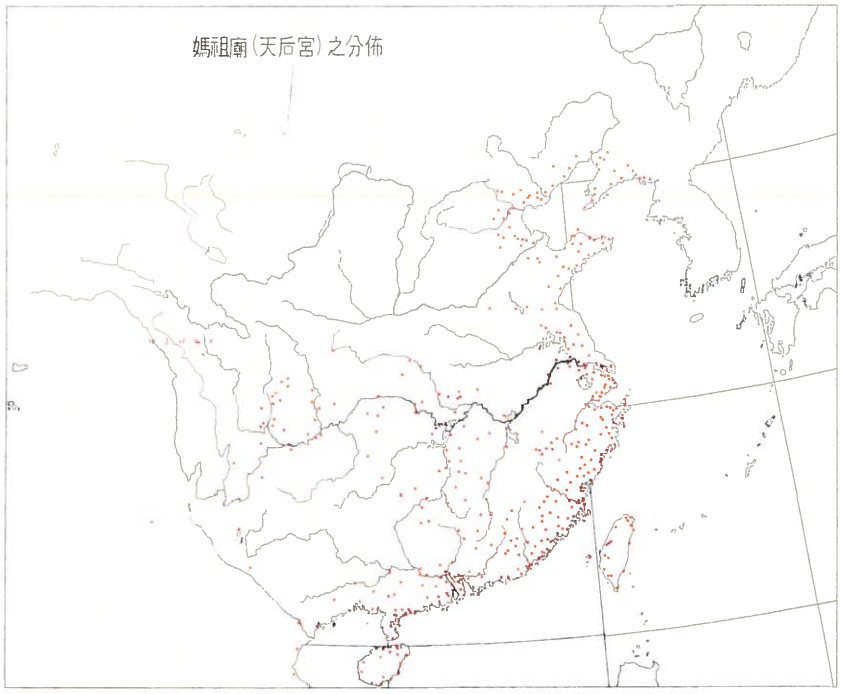
Shown is the geographic distribution of poets (grand total 10,086) during four dynasties, with their birthplaces shifting through centuries toward southeast China and concentrating—as is the case for so much human activity—in a relatively few areas.



Birthplaces of the 3,005 Ming poets, 1368–1644



Birthplaces of the 2,079 Ching poets, 1644–1911



Redrawn from Chen Cheng-Siang, *An Historical and Cultural Atlas of China* (Tokyo, 1981), map 91.

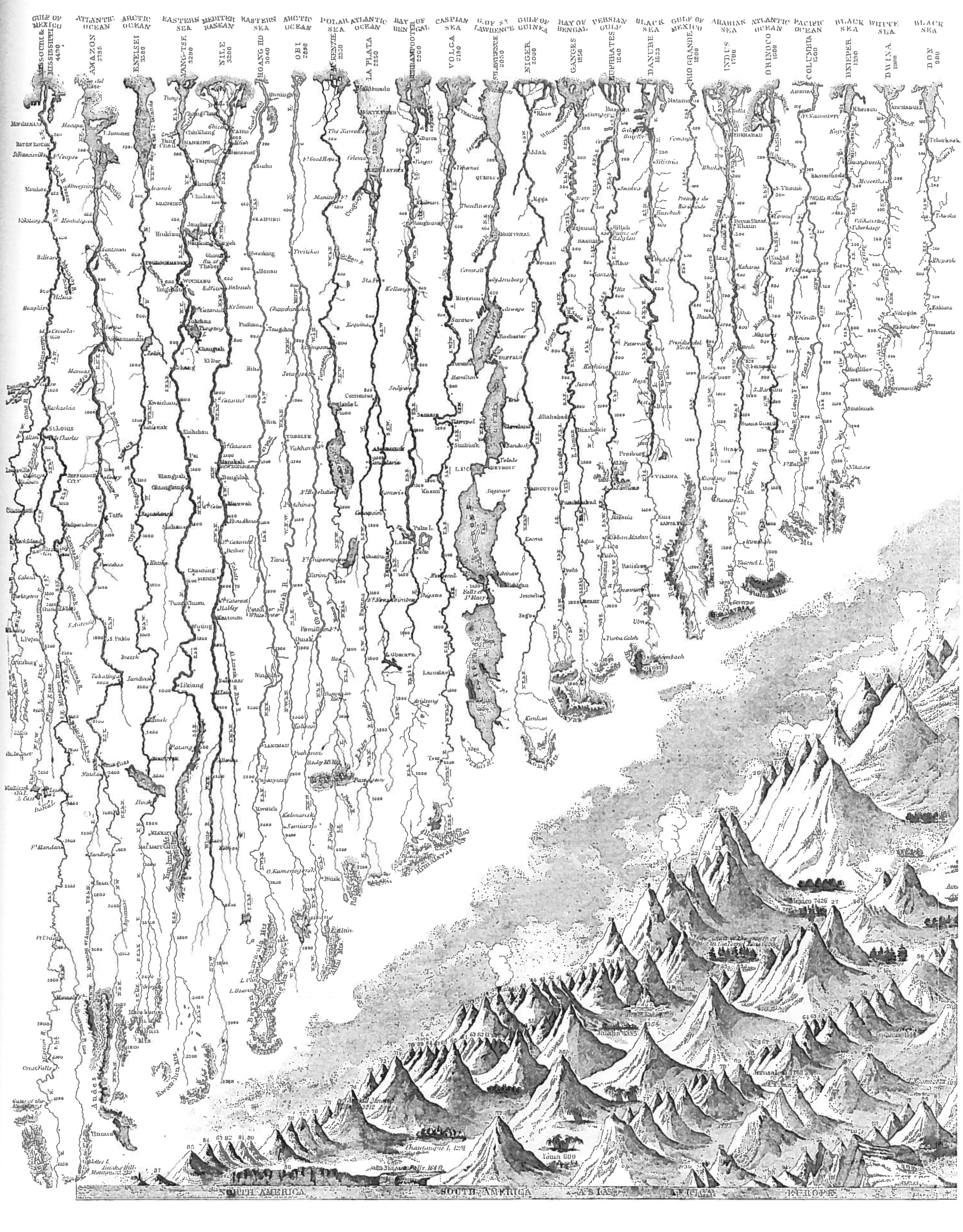
[2] A recent account is by James L. Watson, "Standardizing the Gods: The Promotion of T'ien Hou ('Empress of Heaven') Along the South China Coast, 960-1960," in David Johnson, Andrew J. Nathan, and Evelyn S. Rawski, eds., *Popular Culture in Late Imperial China* (Berkeley, 1985), 292-324.

Ta-ch'eng Ch'eng, *Ma-tsu chuan* (Taipei, 1955), illustration 29.

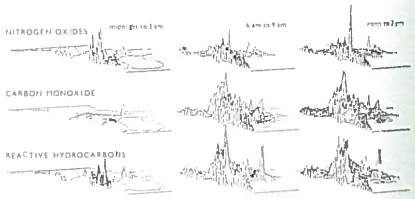
And, finally, a map of distribution of temples of Matsu (T'ien Hou), the most famous sea goddess of China. With a sterling reputation for miracles, she receives prayers of fishermen and sailors during stormy weather; and when the sea is as dark as ink, she provides a torch on the top of the mast to guide small boats to safety. In recent times, the story goes, one mother (an alleged descendant of the goddess) left her child at a temple while going to work on the farm, saying "Sea Goddess, please take heed." Matsu's reaction to supervising a day-care facility was not recorded. Our display here, growing from surpassingly incomplete data, marks prefectures with a temple honoring Matsu.[2] But we are unable to make the long-awaited comparisons among geographic distributions of sea-goddess temples and birthplaces of Tang, Sung, Ming, and Ching poets—because the poets are stranded over on the two preceding pages. *Comparisons must be enforced within the scope of the eyespan*, a fundamental point occasionally forgotten in practice.

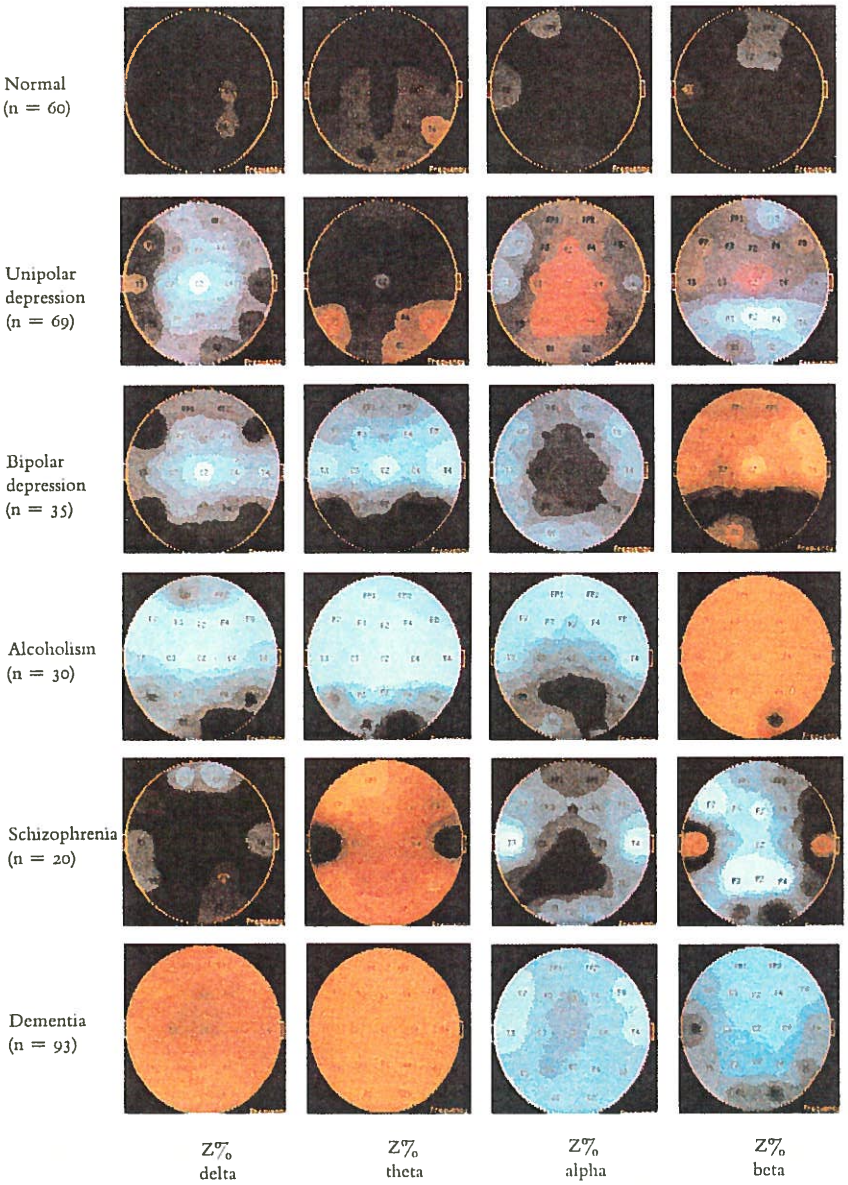
The struggle between maintenance of context and enforcement of comparison is reflected in a 19th-century topographic diagram at right. Surveying lengths of the world's rivers, the chart hangs them out, in parallel more or less, while still retaining specifics of place-names, lakes, and river branches. Note the various sequences of lakes, here linearly arranged. Without such detail, this is just another decorated bar chart. Some ardent typography sets oceans rippling at top. The juxtaposed mountains are less successful, too arbitrary in their relocation, and too stylized and lacking the nice local particulars of the rivers.

Joseph Hutchins Colton, *Johnson's New Illustrated Family Atlas with Physical Geography* (New York, 1864), 10-11.

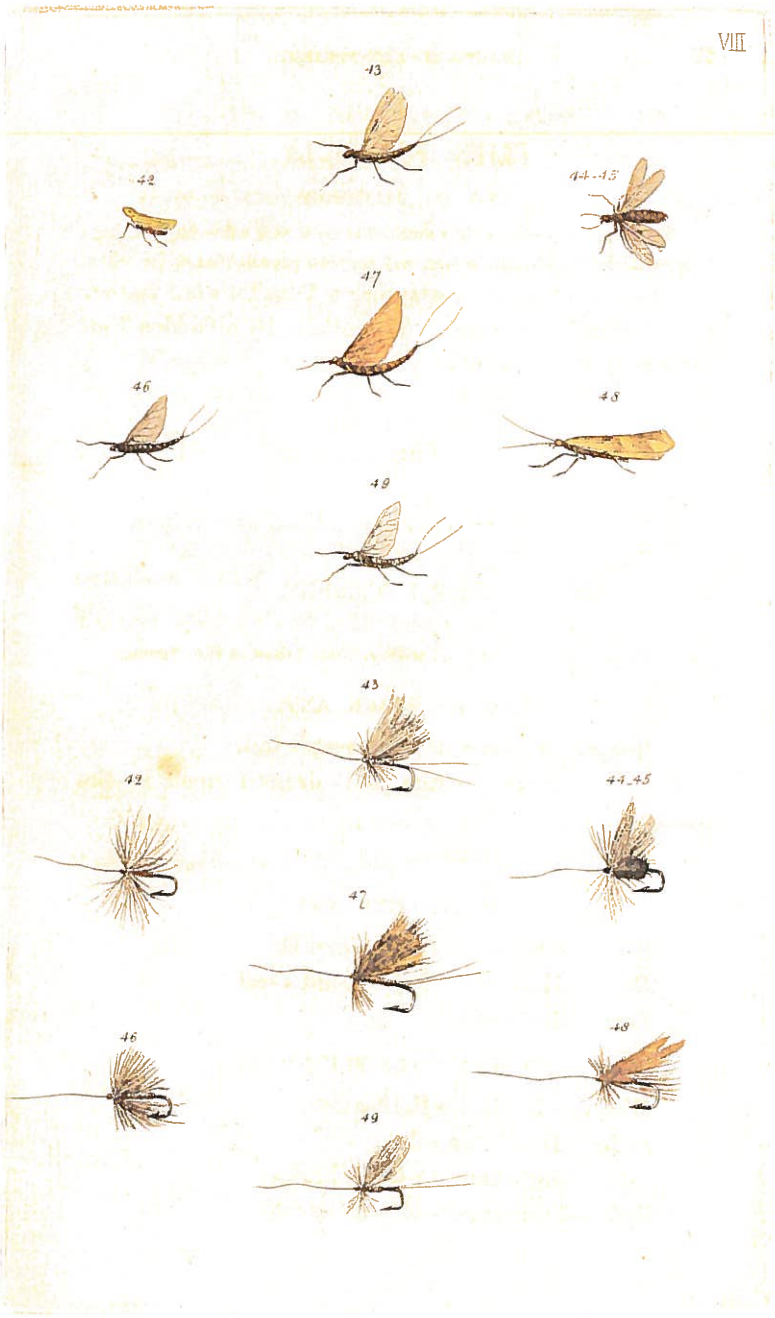

GULF OF MEXICO
MISSOURI & MISSISSIPPI 4400
ATLANTIC OCEAN
AMAZON 3795
ARCTIC OCEAN
YENISEI 3580
EASTERN SEA
YANG-TSE 3290
MEDITERRANEAN
NILE 3200
EASTERN SEA
HOANG HO 3040
ARCTIC OCEAN
OBI 2680
POLAR SEA
McKENZIE 2350
ATLANTIC OCEAN
LA PLATA 2250
BAY OF BENGAL
BRAHMAPOOTRA 2200
CASPIAN SEA
VOLGA 2190
G. OF ST LAWRENCE
ST LAWRENCE 2050
GULF OF GUINEA
NIGER 2000
BAY OF BENGAL
GANGES 1850
PERSIAN GULF
EUPHRATES 1840
BLACK SEA
DANUBE 1633
GULF OF MEXICO
RIO GRANDE 1800
ARABIAN SEA
INDUS 1700
ATLANTIC OCEAN
ORINOCO 1600
PACIFIC OCEAN
COLUMBIA 1500
BLACK SEA
DNIEPER 1350
WHITE SEA
DWINA 1000
BLACK SEA
DON 900
NORTH AMERICA
SOUTH AMERICA
ASIA
AFRICA
EUROPE

Simultaneous two-dimensional indexing of the multiplied image, flatland within flatland, significantly deepens displays, with little added complication in reading. These neurometric maps record distributions of brain electrical activity, arraying data over a matrix of color images—with frequency bands (delta, theta, alpha, and beta) sorting the columns, and individual diagnosis forming the rows. The contour lines depict only the average differences (normalized z-scores) of the row *group* compared to a healthy reference *group*, and thus do not show overlaps or extreme outlying values of all the *individual* members of each group.[3] Graphically, this recursive design resembles the Los Angeles smog chart that we saw in Chapter 1, where maps were themselves spread on two dimensions, type of pollution and time of day.





[3] E. R. John, L. S. Prichep, J. Fridman, and P. Easton, "Neurometrics: Computer-Assisted Differential Diagnosis of Brain Dysfunctions," *Science*, 239 (January 8, 1988), 162-169. The authors conclude: "Healthy persons display only chance deviations beyond the predicted ranges. . . . Patients with neurological impairments, subtle cognitive dysfunctions, or psychiatric disorders show a high incidence of abnormal values. The magnitude of the deviations increases with clinical severity. Different disorders are characterized by distinctive profiles of abnormal brain electrical features. . . . These methods may provide independent criteria for diagnostic validity, evaluations of treatment efficacy, and more individualized therapy."



John Jackson, *The Practical Fly-Fisher; More Particularly for Grayling or Umber* (London, 1854), plate VIII, at 26–27, insects and flies for July and August.

In our neurometric example at left, the dark colors surrounding each image generate disruptive white stripes. Locations can be signaled by nearly silent methods, as above, where an implicit grid pairs each insect with its fly-fishing simulation. And the limited but focused color here is more effective than strong rainbow colors, for reasons now to be revealed.