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Left Snails and Right Minds

Were early conchologists choosing sides when they held the mirror up to nature?

by Stephen Jay Gould

What immortal hand or eye
Could frame thy fearful symmetry?

William Blake's familiar inquiry about the creation of tigers raises a vital question that we may pose literally, although the poet's intention may have been more metaphorical. Why does symmetry, particularly our own bilateral style of mirror images around a central axis, predominate among animals of complex anatomical design? Why do we come in equivalent right and left halves? And why do we get so fascinated by the minor departures, usually more of function than overt form, that loom so large in our culture: the predominance of right-handedness and the difference between "right" and "left" brains?

A few major groups of organisms do not present a basically bilateral symmetry, including my own favorite subject for research, the gastropods, or snails. The soft body of a snail is tolerably bilateral when pulled from the shell and stretched out, but the animal houses this body in a shell built by winding a tube in one direction around an axis of coiling. The snail shell may therefore be the most familiar nonbilateral form among "higher" animals.

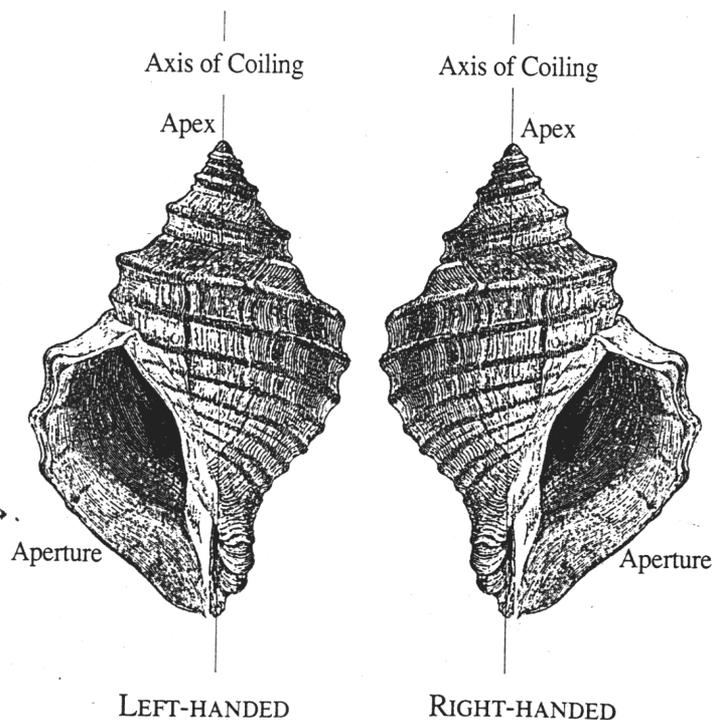
A tube can be wound around a vertical axis in either of two directions, designated as right- and left-handed. If we hold a snail in our conventional position, with the apex at the top and

the aperture (or opening for the body) at the bottom, then we call the direction of coiling right-handed if the aperture lies to the right of the axis of coiling when we view the specimen face to face, and left-handed if the aperture lies to the left of the axis of coiling. (All this should be much clearer in the illustration below than in any words I can supply.)

But this naming is truly arbitrary, for snails know nothing about apex up and aperture down (in life, most snails carry their shells more or less horizontal to the ground). If we draw the specimen apex down (as French scientific illustrators have always done), then the apertures of right-handed specimens open to the left of the axis of coiling.

In India, for example, the conch shell *Turbinella pyrum* is venerated as a symbol of Vishnu. (In the *Bhagavad-Gita*, Vishnu, in the form of his most celebrated avatar, Krishna, blows his sacred conch shell to call the army of Arjuna into battle.) The exceedingly rare left-handed specimens of this shell are particularly treasured and used to sell for their weight in gold. But Hindus interpret the apex as the bottom of the shell and therefore call this rare form right-handed. Perhaps they treasure these rare shells because only these specimens, in the Indian version of an arbitrary decision, match the style of dominant handedness in human beings (and, I suppose, anthropomorphic deities).

A purist might forgive snails for departure from the bilateral paradigm if only they honored an even more inclusive symmetry by growing right- and left-handed spirals in equal numbers. But snails remain twisted and awry on this criterion as well—for right-handed shells vastly outnumber lefties not only in the sacred conch of India but in virtually all species and groups. Right-handed shells are called dextral, from the Latin *dexter*, meaning "right," and memorialized in our language by a host of prejudicial terms invented by the right-handed majority to honor their predominance. Right is dexterous, not to mention "correct" in many languages—awright buddy. The law, by



the way, is *droit* in French and *Recht* in German, both meaning “right.” (The language police will never regulate these essays, but it remains fair and historically interesting to point out that the “rights of man,” noble as the sentiment may be, embody two linguistic prejudices of unfairly dominant groups.) Left-handed shells are called sinistral, from the Latin *sinister*, meaning “left”—also denigrated in our languages as *sinister* or *gauche*, a French lefty. I shall, for the rest of the essay, use this terminology by calling right-handed shells dextral, and lefties sinistral. I also can’t help wondering if we didn’t make our initial arbitrary decision to call a snail’s apex “up” because this orientation would then allow us to designate this overwhelmingly more common direction of coiling as “right.”

The vast majority of forms grow a dextral shell, although a few sinistral specimens have been found in most species. For example, in *Cerion*, the West Indian land snail that forms the subject of my own technical research, only six sinistral specimens have ever been found, out of millions examined (while, as stated above, a lefty *Turbinella* in India was literally worth its weight in gold). A few species grow exclusively or predominantly sinistral shells, but related species of the same group are usually dextral. We often exact a price from these rare sinistrals by giving them names to match their apostasy—as in *Busycon contrarium* or *B. perversum*, the technical monikers variously awarded to the most common sinistral species of northern Atlantic waters. A few groups of species (notably the family Clausiliidae) are predominantly sinistral but, again, all closely related lineages are dextral. In short, dextral snails greatly predominate (at a far higher frequency than human righties versus lefties) at all levels: individuals within a species, species within a lineage, and lineages within larger groups.

At this point, astute and inquisitive readers will be asking the obvious questions, “Why? What conceivable advantage does dextrality hold over coiling in the other direction?” I can only report that these inquiries are both appropriate and fascinating—and that we don’t have a clue about the answers. (I would not even assume that the questions should be posed in terms of putative advantages. The two modes might be entirely equivalent in functional terms, with dominant dextrality only a historical legacy of what happened to arise first.) I’m sorry to wimp out on such interesting questions, but I can at

least quote, on the same subject and to the same point, that greatest of all prose stylists in natural history, D’Arcy Wentworth Thompson (from his book *On Growth and Form*, first published in 1917 and still vigorously in print): “But why, in the general run of shells, all the world over, in the past and in the present, one direction of twist is so overwhelmingly commoner than the other, no man knows.”

This essay, instead, shall take another turning on the subject of directionality in coiling—namely, the history of illustrations for snail shells in zoological treatises. Let me begin with a figure that I first considered both anomalous and amusingly in error. The plate reproduced below is from a famous work in natural history,

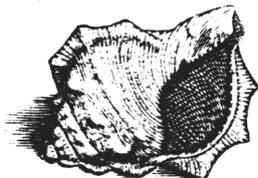
published in 1681 by one of Britain’s finest physicians and zoologists, Nehemiah Grew: *Musaeum Regalis Societatis, or a description of the natural and artificial rarities belonging to the Royal Society, whereunto is subjoined the comparative anatomy of stomachs and guts*. (They did love long titles back then, and we will ignore the appendix, with its remarkable illustrations of vertebrate intestines, all stretched out and circling the pages.)

Note that all but one of these shells are sinistral in Grew’s engraving. The exception, shown at the bottom, is conventionally dextral. Has the world turned? Those shells are labeled “wilk,” or “whelk” in our modern spelling (a common name for conchlike shells)—and nearly all whelks are dextral, including the species shown here. The exception, drawn dextrally, gives the story away by the name imprinted above: “Inverted Wilk Snail.” In other words, the shell labeled “inverted” is, in life, a rare sinistral named according to an old tradition for derogatory designation of the unusual. (At least “inverted” seems milder than “perverted,” as in *Busycon perversum*.)

Obviously, Grew printed his snails in mirror image from their actual constitution. I initially assumed that Grew had committed a simple error and laughed at his fellowship with snail men throughout the history of illustration, for we are still making the same mistake today. In the current version, an offspring of modern technology, a snail may appear with reversed coiling because the photograph has been made from a negative inadvertently turned over before printing. Any expert paying explicit attention will notice the error, but we fallible mortals often let something this global slip by—for a reversed snail doesn’t look grievously wrong if you don’t have your eye and mind directly attuned to the issue of symmetry.

Any professional snail man can give you his list of embarrassments in this category. A dear late colleague, one of the world’s leading experts on snails, published a beautiful wraparound dust jacket photo of reversed shells for the cover of his popular book. I must also admit (and how wonderfully unburdening after all these years of hiding such a shameful secret) that my own first publication on snails included several photographs of a newly discovered protoconch (embryonic shell) of an important genus—all published from reversed negatives. (I received the sweetest and most diplomatic letter from a colleague asking me if these dex-

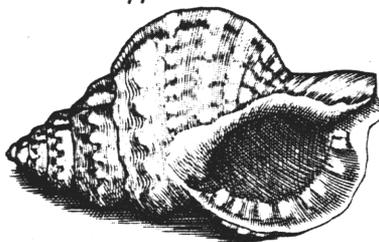
Square Wilk



Long Square Wilk



Thick Lipp'd Wilk



Triangular Wilk



Inverted Wilk Snail



In an illustration from Nehemiah Grew's 1681 volume, only the bottom snail is shown coiling to the right.

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tral shells really had sinistral protoconchs and urging me to publish separately on such an important finding, or suggesting that maybe, just maybe, I had made the old error of reversed printing.) Baseball players make a proper distinction between physical errors, which can happen to anyone anytime and should engender no shame, and mental errors—bonehead judgments, forgetting the rules—which should never occur. Ordinary and honorable errors of fact are unavoidable in science, a field that thrives on self-correction, and properly defines its own progress by such improvement. I have never written an essay, and never will, without this analogue of a physical error. But printing a snail backward is a mental error. No excuses possible.

So much for my first thoughts about Grew's mistake. But as soon as I remembered a scholar's first obligation—to drag oneself from judgment within a smug present, considered better, and to place oneself, so far as possible, into the life and times of a person under consideration—I immediately realized that the issue could not be so simple. All media for printed illustration in pre-nineteenth-century treatises of natural history—woodblock printing, engraving on metal plates, lithography—require the initial production of an inverted image. That is, the engraver must carve a mirror image figure into his metal plate, so that the paper, placed atop the inked plate before pressing down to print, will receive the figure in proper orientation. Needless to say, all printers know this rule perfectly well; nothing could be more fundamental to their work.

Therefore, a printer who wants to engrave an ordinary dextral shell must carve a sinistral image upon his metal plate. Clearly, Grew's printer drew the snails onto his plate as he saw them, rather than reversed—and the result is an inverted image in the printed book: ordinary dextral snails look sinistral, and the lone sinistral looks like a conventional dextral.

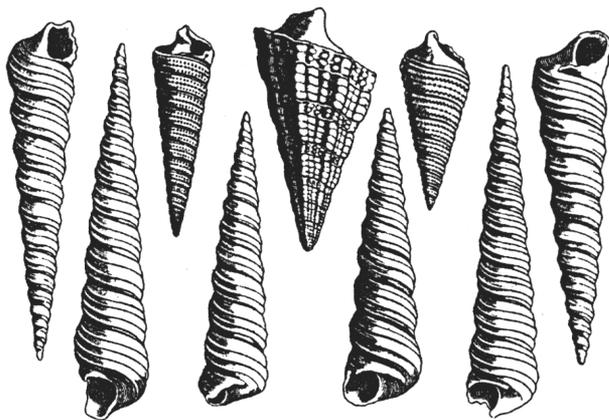
But how did this happen? and why? This oddity cannot be the result of a simple fool's error of the baldest kind, for the engraver surely knew his rules and must have etched his letters and numbers in proper reversed order onto his plate, for all writing and numeration is correct in the printed version. Many scenarios suggest themselves, and we do not have enough evidence to decide: perhaps Grew supplied his printer with sketches already reversed but forgot to pass this information

along; perhaps Grew provided all the sketches on a single sheet (without the words), and the printer then erred in pasting the sketch upon his plate recto rather than the proper verso. (I am assuming that engravers worked by affixing a sketch, drawn on transparent paper, directly onto their plate and then carving through.)

But we should also consider a hypothesis of a fundamentally different kind. Perhaps we should not be so quick to assume, from our arrogant present, that these "primitives" of the seventeenth century must have been making an error at par with boo-boos still occasionally committed by modern photography. Perhaps the reversed shells of Grew's illustrations are not errors at all, but representations of a convention then followed and now abandoned.

I shall defend this more generous alternative in concluding my essay, but I had not considered this solution when I first saw Grew's plate about ten years ago. I simply stored this little "fact" away in my mental file of oddities in natural history. I must have labeled this item "Grew's funny mistake," for I never considered the possibility that reversed snails could be anything but an error, however committed.

As their primary virtue and utility, such mental files can lurk in the brain (wherever and however this remarkable organ stores such information) without disturbing one's thinking and planning in any manner. The files just hang around, waiting for some trigger to transport them into consciousness. (I would, for this reason, defend such ancient practices as rote learning for the basic chronology of human history and for reading the classics, particularly Shakespeare and the Bible, with a view to memorizing key passages.) I love antiquarian books in natural history, and my eyes do inevitably wander, for professional reasons, to pictures of snails. Thus, my "Grew mistake" file has been accessed quite a few times during the past decade. But I never had any project in mind, and I had devised the wrong preliminary conclusion about Grew's reversals. In fact, it took three or four random repetitions to make the subject explicit as a wor-



Dextral-coiling species are consistently shown as sinistral in a 1719 edition of Michele Mercati's Metallotheca.

thy topic, to force a revision of my own initial error, and to perceive the larger theme about science and human perception that could convert such a trivium (the depiction of snail coiling) into a decent subject for an essay.

A few years after my reading of Grew's book, I purchased a copy of my personal favorite among beautiful and important works in natural history, Michele Mercati's *Metallotheca*. Mercati (1541–1593), director of the Vatican botanical garden, also became curator of the papal collection of minerals and fossils organized under the aegis of the imperial pope Sixtus V, whose taxes impoverished the papal lands while building Rome in splendor. (I also love the man's name—the fifth instar of a guy named "six"; Sixtus I, a second-century figure, was the sixth bishop of Rome after Peter and took his name accordingly.) Mercati prepared a series of gorgeous engravings for a catalog of the Vatican collection, but this work never appeared in his lifetime (perhaps because Sixtus V died unexpectedly in 1590). But the plates hung around in the Vatican's vast storehouses for nearly a century and a half, until J. M. Lancisi finally published them, along with Mercati's text and many new engravings, in 1719 as the *Metallotheca*. (If a *bibliothèque* is a library, then a *metallothèque* is a collection of metals and other objects of the mineral kingdom.)

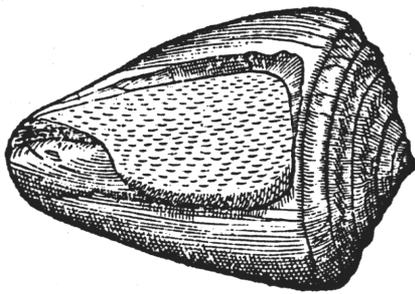
The *Metallotheca* contains numerous plates of fossil snails in a chapter called *Lapides Idiomorphoi* (or stones that look like living things—Mercati, along with many sixteenth-century scholars, did not interpret fossils as remains of organisms but as manifestations of "plastic forces" inherent in rocks). In all plates—so we are in the presence of a conscious generality,

not an individual error—dextral snails appear as sinistral engravings.

But assumptions die hard, even if never founded on anything sensible. I couldn't call reversed printing a simple error any more, so I opted for the next line of defense within the bias of progress: I assumed that such indifference to nature's factuality must represent a curious archaicism of the bad old days (for Mercati goes way back to the sixteenth century)—and thus not worthy of much intellectual attention. Again, I stored the observation on the back shelves, in the stacks of my mentathea.

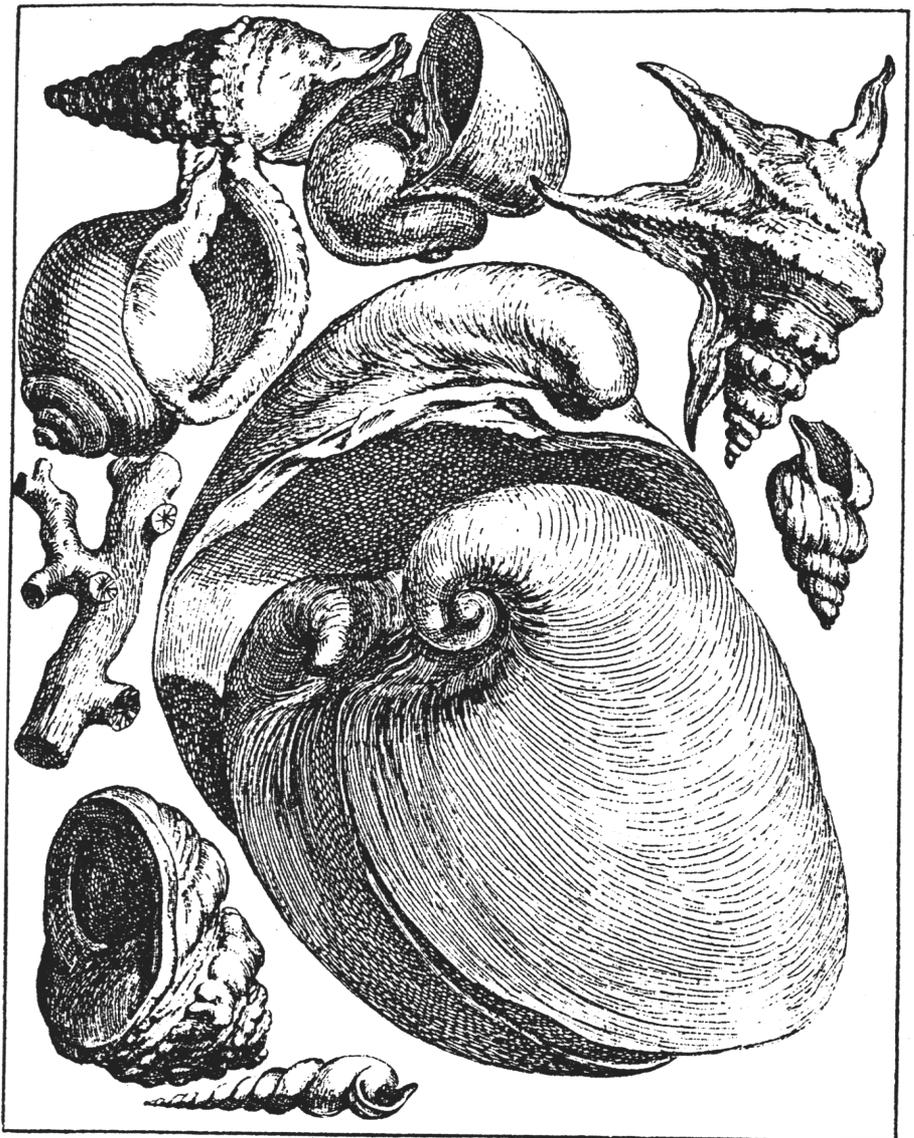
More random encounters since then have finally shaken up my false assumption, for I have noted sinistral illustrations of dextral shells again and again in works published before 1700. In fact, almost all snail illustrations from this period are reversed, so we must be observing a conscious convention, not an occasional error. By contrast, I have almost never seen a reversed illustration in works, say, from Linnaeus's time (early to mid-eighteenth century) onward, except as real and infrequent errors. Therefore, and interestingly, the obvious hypothesis that photography ushered in the change must be false. I simply do not know (but would dearly love to have the answer) why a convention of drawing snails in reversed coiling yielded to the conviction that we should depict them as we see them.

To shorten my chronicles of personal discovery, two further examples finally convinced me that older illustrations had drawn snails with reversed coiling on purpose. I first consulted as close to an "official" source as the sixteenth century can provide—the *Musaeum Metallicum* (another account of a major fossil and rock collection) by the Italian naturalist Ulisse Aldrovandi (1522–1605), who, in competition with his Swiss colleague Konrad



A dextral snail, shown with sinistral coiling in *Musaeum Metallicum*, by sixteenth-century Italian naturalist Ulisse Aldrovandi

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Dextral snail species are depicted with left-handed coiling in a volume on fossil snails by seventeenth-century paleontologist Augustino Scilla.

Gesner (1516–1565), wrote the great compendia that pulled together all available knowledge about animals—ancient and modern, story and observation, myth and reality, human use and natural occurrences. My edition of Aldrovandi's posthumous work on fossils dates from 1648 and illustrates all snails as sinistrally coiled, although the figures depict dextral species.

If the standard source still doesn't completely convince, then seek an author with special expertise. I therefore consulted my copy of one of the great works in late-seventeenth-century paleontology, *De Corporibus Marinis Lapidescensibus* (On Petrified Marine Bodies) by Augustino Scilla (my Latin edition dates from 1747, but Scilla first published his work in Italian in the 1690s). I decided on Scilla as a final

test case because he was a painter by trade, a leading figure on the *seicento* in Sicily, and he engraved his own plates. All his snails are dextral species, and all are engraved with sinistral coiling. Clearly, if standard sources and noted artists all drew snails in mirror image from their natural occurrence, they must have been following a well-accepted convention of the time, not making an error.

But why would earlier centuries have adopted a convention so foreign to our own practices? Why would these older illustrators have chosen to depict specimens in mirror image when they surely knew the natural appearance of these shells? Did they devise this convention in order to make life easier for a profession founded on the principle that one carves in reverse in order to print in the desired orientation?

But if so, what aid could be provided by the convention of printing snails in reverse? I suppose that an engraver could then paste a picture directly on his plate and cut through with maximal visibility (whereas the usual technique forced him to invert the drawing before affixing it to the plate, thus making him view the sketch through the backside of the paper; but papers of adequate transparency must have been available, and I wonder if the usual technique really imposed any great hardship. Or did engravers mechanically copy an original figure in reverse orientation and then paste this copy onto the plate? If so, a convention permitting reversed printing would allow engravers to omit a time-consuming step).

Whatever the reason, the very existence of the convention does, I think, teach us something important: the conceptual world of pre-eighteenth-century zoology must have accorded little importance to the orientation of a shell. These men were not stupid, and they were not primitive. If they were willing to sacrifice what we would call "accuracy" for some gain in ease of production (or for some other reason not now apparent to us), then they must have held a notion of accuracy quite different from ours. The recovery of "fossil" thought patterns from such intriguing hints as this small, but previously unnoted, change in a practice of illustration provides the kind of intellectual lift that keeps scholars going.

The greatest impediment to such recovery—one that infested my own first thoughts on this issue and precluded any movement toward a proper solution after I had made my initial and accurate observations—lies in lamentable habits imposed by the twinned biases of progress and objectivity. We assume that we now do things better than at any time in the past, and that our improvements record increasing objectivity in shedding old prejudices and learning to view the world more accurately. We therefore interpret our predecessors, especially when their views differ from ours, as weighted down by biases and lacking in data—in short, as pretty darned incompetent compared with us. We therefore do not take them seriously, and we view their differences from us as crudity and error. Thus, we cannot understand the interesting reasons for historical changes in practice, and we cannot recover the older systems, coherent in their own terms (and often based on a fascinatingly different philosophy of nature), that made the earlier procedures so reasonable.

The key, in this case, lies in realizing that an apparent error in past practice represents a convention, now foreign to our concepts but evidently pursued for conscious reasons by our predecessors. We must still overcome one obstacle in striving to view the past more sympathetically (thereby gaining insight into present styles of thinking). We might understand that printing snails in reverse represented a convention, not an error, but still hold (via the bias of progress) that the history of changing conventions must record a pathway to greater accuracy in representation. We might, for example, hold (in utmost naiveté) that our predecessors once drew what they wanted to see, whereas we now photograph what actually is.

Two arguments should convince us that history marks no path from stilted convention to raw accuracy. First, I have talked with many professional photographers, and all recognize as a canard the old claim that their technology gave us objective precision, where only subjective drawing reigned before. Technological improvements in photography do make older styles of prevarication less possible. (In my book *The Mismeasure of Man*, I showed how one pioneer eugenicist doctored his pictures of supposedly retarded people to make them look more benighted. His retouchings are so crude that no one today, with a lifetime of experience in looking at good photographs, would be fooled. But he got away with his ruse in 1912, for few people then had enough experience to recognize a doctored photo, and retouching represented an accepted art for repairing crude shots in any case.) But other technological improvements make all manner of fooling around with photos ever more possible and elaborate (just think of Woody Allen as Zelig, or Tom Hanks as Forrest Gump, artificially incorporated into the great events of twentieth-century history by trick photography). Who can balance the gains and losses? Why speak of these changes as gains and losses at all? We have not dispensed with conventions for accuracy; we have only adopted different conventions.

Second—and the clinching argument that made me decide to write this essay—we have not, even today, abandoned all conventions for reversed illustration. In fact, one highly prestigious and technologically "cutting edge" field continues to present upside-down photographs, just as our forebears drew their snails right to left. How many readers realize that conventional photos of moons and planets are up-

side-down? (If you doubt my claim, compare the full moon on a clear night with the photograph in your old astronomy text). Modern astronomers, of course, are no more fools than the old snail illustrators. They present photographs upside down to match what one sees in conventional refracting telescope. (Or, rather, they print the photos as they are taken through such telescopes. Is this convention any different from carving a snail as one sees it onto an engraving plate and then producing the paper image in reverse?)

Clearly, astronomers feel that the trouble taken to print photographs from refracting telescopes upside down (thus rendering the object as it exists in the sky) would not be worth the gain. In fact, one might argue that reversing the photo would sow confusion rather than provide benefit, for with the exception of our moon, we cannot see features of other moons and planets with our naked eye, and therefore know these bodies primarily as seen through refracting telescopes—that is, upside down. I must suppose that the old snail illustrators also regarded the direction of coil as unimportant for illustration—and I would like to know why. I would also like to know what triggered the change from an accepted convention to a no-no.

I shall not, either in this forum or anywhere, resolve the age-old riddle of epistemology: how can we "know" the "realities" of nature? I will, rather, simply end by restating a point well recognized by philosophers and self-critical scientists, but all too often disregarded at our peril. Science does progress toward more adequate understanding of the empirical world, but no pristine, objective reality lies "out there" for us to capture as our technologies improve and our concepts mature. The human mind is both an amazing instrument and a fierce impediment—and the mind must be interposed between observation and understanding. Thus, we will always "see" with the aid (or detriment) of conventions. All observation is a partnership between mind and nature, and all good partnerships require compromise. The mind, we trust, will be constrained by a genuine external reality; this reality, in turn, must be conveyed to the brain by our equally imperfect senses, all jury-rigged and cobbled together by that maddeningly complex process known as evolution.

Stephen Jay Gould teaches biology, geology, and the history of science at Harvard University.