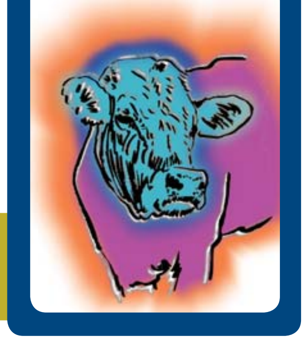

Monsters & the Tyranny of Normality

How do biologists interpret anomalous forms?

DOUGLAS ALLCHIN, DEPARTMENT EDITOR

In the sixteenth and seventeenth centuries, monsters were wonders (Allchin, 2007b). Anomalous forms – like conjoined twins, hermaphrodites, hydrocephalic babies, or the extraordinarily hairy Petrus Gonsalus and his equally hairy children – amazed people. They evoked a spirit of inquiry that helped fuel the emergence of modern science. Today, however, such bodies tend to strike us as freakish or grotesque – possibly even "against nature." How did our cultural perspective, and with it, our values and emotional responses, change so radically?

The shift in cultural views paralleled, ironically, deepening scientific understanding. Exceptions and anomalies can be powerful investigative tools. In this case, human monsters eventually prompted a new science, *teratology*, which compared normal and abnormal development. The scientific explanations and categories seemed to support value judgments. The history of monsters helps reveal the roots of a common belief (another sacred bovine?): That the "normal" course of events reflects nature's fundamental order. Well construed, monsters can help us rethink the meaning of normality and of the concept of laws of nature.

Leveraging Exceptions

Monsters are fascinating, of course, because they do not fit customary expectations. Such exceptions can be valuable opportunities for interpreting the *un*exceptional. One can begin to look for the relevant differences that reflect the underlying cause in both cases. It is a classic research strategy, especially in biology. Loss or modification of a structure can highlight its function.

So, for example, vitamins were discovered through vitamin deficiency diseases, such as scurvy and beriberi. Likewise, the role of proteins in gene expression emerged from studying heritable enzyme deficiencies, such as alcaptonuria and phenylketonuria. Sickle cell anemia has become a classic example in textbooks, in part because it was important historically in understanding hemoglobin and protein structure, as well as the evolutionary consequences of pleiotropy (Howe, 2007).

Similarly, diabetes provides insight into insulin and the physiology of regulating blood glucose. Slips of the tongue are clues to how the brain processes language (missed notes in playing piano, too!) (Erard, 2007). Autism is opening understanding of the physical architecture of synapses (Garber, 2007). The dramatic influence of non-native species, such as zebra mussels or gypsy moths, reveals how coevolved relationships often stabilize ecosystems. Biological systems at all levels can be understood when customary patterns are disrupted.

Exceptions, or anomalies, were an obsession in the early 1600s for Frederico Cesi, founder of perhaps the earliest scientific institution, the Accademia Lincei (Freedburg, 2002). Cesi's foremost goal was to document and classify every organism on Earth. He was thus intrigued by specimens that fit two categories at once. A bat seemed like both rodent and bird. But it could not be both. It posed a puzzle for how to adjust the existing categories. What were goose barnacles? –a fungus that generated a shell? Why did they produce what seemed like feathers? Double fruits, lemons with various excrescences, and other "monstrous" forms, Cesi regarded as cryptic clues to nature's order.

Physician and anatomist William Hunter would echo such sentiments nearly two centuries later:

> *Even monsters, and all uncommon, and all diseased animals productions, are useful in anatomical enquires; as the mechanism, or texture, which is concealed in the ordinary fashion of parts, may be obvious in a preternatural composition.*

In such examples, he rhapsodized, nature "has hung out a train of lights that guide us through her labyrinth" (1784, p. 4). Monsters offered deeper insight into ordinary nature.

From Anomalous to Pathological

The growing desire in the 1600s to understand monsters, along with other wonders and "preternatural" phenomena, helped motivate the growth of modern scientific investigation. As the study of nature expanded, belief in nature's regularities became more firmly established. Over the century, the concept of "laws" of nature developed–with ultimately profound consequences.

Initially, such prospective laws included how monsters formed. In 1703 Bernard de Fontenelle, Secretary of the Paris Royal Academy of Sciences, expressed such faith:

> *One commonly regards monsters as jests of nature, but philosophers are quite persuaded that nature does not play, that she always inviolably follows the same rules, and that all her works are, so to speak, equally serious. There may be extraordinary ones among*

DOUGLAS ALLCHIN has taught both high school and college biology and now teaches History of Science at the University of Minnesota, Minneapolis, MN 55455; e-mail: sacred.bovines@nabt.org. He is a Fellow at the Minnesota Center for the Philosophy of Science and edits the SHiPS Resource Center (ships.umn.edu). He hikes, photographs lichen, and enjoys tea.

them, but not irregular ones; and it is even often the most extraordinary, which give the most opening to discover the general rules which comprehend all of them.

In monsters, he professed later, nature "cannot avoid sometimes betraying its secret" (Daston & Park, 2001, pp. 204-205).

Monsters thus became integral to early eighteenth-century debates about the "laws" or principles of development. For example, did the mother's imagination contribute to the form of the fetus? Exotic monsters seemed the result of dreams or bizarre experience, not ordinary nature. Such a view was widespread until challenged in 1727 by James Blondel, who helped shift views towards more purely material processes. Also, were monsters foreordained or the result of "accidental" factors during fetal growth? Here, Nicholas Lemery advocated the later, suggesting that conjoined twins resulted when by chance two eggs merged. His arguments were not uniformly accepted, however. Another debate concerned whether embryos exhibited essential structure from the outset (preformation) or whether their structure developed only gradually, varying with context (epigenesis). Throughout these decades, monsters were important test cases for any theory of development (New York Academy of Medicine, 2007; Daston & Park, 2001, p. 204).

In the early 1800s, the belief in nature's regularities and patterns in organisms were expressed through "philosophical anatomy." Different organisms, both within and across species, could be related through idealized forms. German Romantic poet and naturalist Johann Wolfgang Goethe saw unity of structure even within organisms. All plant organs (flowers, bracts, tubers, tendrils, etc.) were, he claimed, fundamentally leaves (Bortoft, 2004). In France, Étienne Geoffroy Saint-Hilaire advocated a law of "unity of composition." Geoffroy extended the unity to monsters. "There is monstrosity," he noted, "but not, by virtue of that, suspension of ordinary laws." He called it a "manifest contradiction" to imagine two separate sets of laws governing development. All reflected variants of a model pathway. "The normal state of humans may be considered like the abstract being, or generic being, and their different pathological deviations, like the species of this ideal type" (1822, p. 106, 105, 15).

Geoffroy's follower, Étienne Serres, studied monsters – notably, a famous pair of conjoined twins, Ritta and Christina – and viewed them as resulting from arrested development. The forms, in Serres' perspective, were incomplete. Geoffroy tried to demonstrate such effects experimentally. Knowing that an egg loses weight as the chick develops, he focused first on the presumed exchange of fluids across the shell. He abraded eggs, pricked them, or covered them with wax or varnish. Later, he considered mechanical disruption. If adherence of embryonic surfaces was altered, he reasoned, changes in blood flow might arrest development in particular locations. Geoffroy varied the position of the eggs, standing some on one end, some on the other. He soaked others in water. Yet others were exposed to periods of lower temperature. –All in an effort to mimic and thereby illustrate the causes of monstrosities. The results were inconclusive. Organisms tended to die rather than develop differently. Geoffroy continued to propound his theories. Still, he had opened an important new area to investigation. Monsters were now an experimental science (Appel, 1987).

Geoffroy's son, Isidore Geoffroy Saint-Hilaire, continued his father's work and helped it achieve greater respectability. He consolidated and extended his father's system of classifying human monsters. He also applied the concept that developmental rates of particular body parts might vary (even if not fully "arrested"). While studying primates, Isidore noted that the crania of the young were relatively larger than the adults'. He speculated (before Darwin had published on evolution) that different developmental rates might explain human brain size. Here, he echoed some of his father's controversial views that monsters might provide clues about Lamarck's transformations between species. Most important, perhaps, Isidore gave the new science of monsters a firmer existence by naming it. It is still known as *teratology*. (Saint-Hilaire, 1932-38; *Dictionary of Scientific Biography,* 1970).

Isidore stressed that despite their unusual appearance, monsters should not be regarded as "failed" normal beings. But philosophical anatomy and its lawlike ideals dominated thought. Teratology became a science of *pathology*. Explaining the anomalous ironically contributed to monsters being cast as "abnormal."

The development of statistics during the 1800s contributed further to viewing monsters negatively. Astronomers and geographers realized that their (re)measurements of the same stars or landmarks varied. The variation exhibited what we now commonly recognize as a bell-shaped statistical distribution. But the stars and land were obviously not moving! Some measurements must be "wrong." The desired figure, or ideal, was surely the mean. They thus labeled the variation – today's "bell curve" – as "the Law of Error." Meanwhile, numbers about all kinds of social phenomena were exhibiting the same Law of Error. The statistical regularities were construed as social *laws*. In the 1830s mathematician Adolphe Quetelet suggested that, rather than discuss groups and their variability, one could refer instead to the "average man" (*l'homme moyenne*) as representative of the whole (Porter, 1986). That concept, too, further endowed the average, or common, with value, while peripheralizing others. Statistics thus helped amplify, and apparently justify, value distinctions between the "normal" and deviations from it.

With faith in lawlike regularities, philosophical anatomy, teratology and statistics, monsters changed in the 1800s from anomalous wonders to pathological errors. Consider, for example, the case of Joseph Merrick, also known as "the Elephant Man," in mid-century. Merrick exhibited the Proteus syndrome (genetically based excessive bone growth). His head was enormous and bulbous, his right arm and left leg inflated with pendulous folded tissue (even while his left arm seemed utterly familiar). His body was strikingly asymmetrical, resulting in uneven movements. Eventually, Merrick reached the care of physician Frederick Treves and was welcomed in London's elite society. But such care was deliberately protective. Treves described how, earlier, "he had been ill-treated and reviled and bespattered with the mud of Disdain" (Howell & Ford, 1980, p. 189) Even under Treves' care, he went hooded and cloaked when traveling in public lest he spark incident. Merrick himself never stopped dreaming of being ordinary. Merrick's unusual form did not evoke fascination, but an alienation to be overcome.

Consider also the case of Alexina/Abel Barbin (Dreger, 1998). Barbin was an intersex. Raised as a girl, s/he was "discovered" as male in 1861 and reassigned an "appropriate" identity. Scandal ensued. Now a male, he was denied marriage to the woman he had loved earlier as a female. He had to relocate. Seven years later, unable to readjust, the tortured Alexina (as she saw herself) took her own life. At that time, there was no place for those who did not fit "nature's" categories of male and female (Allchin, 2006). An intersex "monster" did not receive special regard. Rather, like Merrick (and unlike hirsute Petrus Gonsalus), s/he was an outcast.

Ironically, then, the growth of science contributed to the displacement of monsters from their valued status. With explanations, the extraordinary became ordinary. With laws and patterns characterizing how nature was "supposed" to be, monsters became abnormal deviations. In answering the call of wonder, science ultimately destroyed that very sense of wonder.

Naturalizing the "Normal"

The concept of laws of nature has a powerful hold on our minds. The very language is highly charged. In human society, laws specify what we *ought* to do. They ensure social order. We tend to interpret laws of nature in the same way, as the guarantors of the natural order, profiling how nature *should* act. Once established, *descriptive* laws take on a *prescriptive* character. The laws of "normal" development easily become standards for how organisms "ought" to grow. The normal becomes *naturalized*, or apparently constitutive of nature's order (Allchin, 2007a). At the same time, the abnormal comes to reflect undesirable disorder or chaos. Facts thereby become imperceptibly – but inappropriately – imbued with values. The irony of monsters is that while they are plainly products of nature, they are often viewed as "unnatural" because they seem to "violate" its "laws." The term "monstrous" now implies impropriety, not merely unusualness.

The effect of naturalizing the "normal" is not unlike a paradox of democracy. When one honors exclusively the wishes of the majority, the minority can be wholly disenfranchised. Such "tyranny of the majority" eclipses the political question of how to address dissent. In a similar way, undue focus on the laws of nature, or the normal, can eclipse understanding of exceptions or phenomena not fully described by the laws. One may call it, by comparison, "the tyranny of normality." Scientifically, it means our interpretations of nature may be skewed or incomplete. Culturally, it means monsters – according to the "natural" categories established by "science" – are shunned (or pitied) as abnormal, not welcomed or celebrated as unique.

The history of monsters, from marvel to pathology, invites us to reflect more generally on the tyranny of normality in biology and in teaching. In what ways do we bias our image of nature by focusing primarily on "laws" of nature as fundamental or on normal function as a targeted norm? Sickle cell anemia, diabetes, autism, or invasions of non-native species are no less expressions of biological processes than their often privileged "normal" counterparts. In biology, absolute laws are rare. Exceptions abound. By establishing parity in the classroom, we might foster a fuller, more complete appreciation of nature in all its diverse behavior.

The popular film "Monsters, Inc." playfully upends conventional perspectives. The cartoon monsters are normal; the adorable child is an alarming "other." The humor conveys a lesson that the ordinary is a matter of perspective. So too, then, for the extraordinary. The challenge for biology teachers may be finding the appropriate perspective. Can we reimagine the seventeenth-century view of monsters as wonders, not freaks, without abandoning today's science? Might that perspective also, at the same time, help us view the ordinary, or normal, as wonders, too?

References

Allchin, D. (2006). Male, female, or–? *The American Biology Teacher, 68*(6), 372-375.

Allchin, D. (2007). Social un-Darwinism. *The American Biology Teacher, 69*(2), 113-115.

Allchin, D. (2007b). Monsters and marvels. *The American Biology Teacher, 69*(9), 565-568.

Appel, T. (1987). *The Cuvier-Geoffroy Debate*. New York: Oxford University Press.

Bortoft, H. (2004). *The Wholeness of Nature: Goethe's Way Toward a Science of Conscious Participation in Nature*. Herndon, VA: Landisfarne Books.

Daston, L. & Park, K. (2001). *Wonders and the Order of Nature*. New York, NY: Zone Books.

Dictionary of Scientific Biography. (1970). New York, NY: Scribner.

Dreger, A.D. (1998). *Hermaphrodites and the Medical Invention of Sex*. Cambridge, MA: Harvard University Press.

Erard, M. (2007). Read my slips: Speech errors show how language is processed. *Science, 317*, 1674-1676.

Freedberg, D. (2002). *The Eye of the Lynx*. Chicago, IL: University of Chicago Press.

Garber, K. (2007). Autism's cause may result in abnormalities at the synapse. *Science, 317*, 190-191.

Geoffroy Saint-Hilaire, E. (1822/1968). *Philosophie Anatomique. II. Monstuosités Humaines*. Brussels: Culture et Civilisation Impression Anastalique.

Geoffroy Saint-Hilaire, I. (1832-1838). *Histoire Generale et Particulaire des Anomolies de l'Organisation*. (3 Volumes). Paris: J.B. Bailliere.

Howe, E. (2007). Addressing nature-of-science core tenets with the history of science: an example with sickle-cell anemia and malaria. *The American Biology Teacher, 69*(8), 467-472

Howell, M. & Ford, P. (1980). *The True History of the Elephant Man*. Harmondsworth, UK: Penguin.

Hunter, W. (1784). *Two Introductory Lectures*. London: by order of the Trustees, for J. Johnson.

New York Academy of Medicine. (2007). A telling of wonders: Teratology in Western medicine through 1800. URL: www.nyam.org/initiatives/im-histe_ter1.shtml.

Porter, T.M. (1986). *The Rise of Statistical Thinking*. Princeton, NY: Princeton University Press.