

Distinguished Madame Chairman and Members of the Subcommittee. I am grateful for the honor of speaking here today on science and public policy.

Two historical lessons from science

The brain of *Homo sapiens* reached its present size and configuration around 100,000 years ago, near the onset of the last glacial period, when massive ice sheets strode from the Arctic to envelop the northern regions of North America, Asia and Europe. During this harsh climate, *Neanderthalensis*, the only other hominid species (or sub-species) at that time, and one closely related to *Homo sapiens*, became extinct. Our forebears survived, and our intellectual capacity equals theirs. They left counting sticks – signs of early mathematics – several tens of thousands of years old nicked with notches that perhaps inventoried herds of reindeer followed for access to food. Around 15,000 to 20,000 years ago in caves dotting the knees of the Alps and Pyrenees our ancestors left highly adept sketches of local animals like the woolly rhinoceros.

By 10,000 years ago the swards of ice withdrew, possibly very quickly, as the interglacial period brought an equable climate. The moistening of formerly arid areas of southwest Asia led to the expansion of agriculture, trade, metalworking and cities -- civilization. That expansion not only altered local ecosystems but also revolutionized humans.

Inherently human traits such as creativity, problem solving and social cooperativeness, useful for survival, led eventually to science and modern technology. But they were new to the human record -- prior to that, mythmaking held sway for its power to explain events in the natural world. While myths may proceed logically, rationally and appealingly from an assumption, the assumption may be flawed. Science can test for flawed assumptions.

Science requires special protection granted by society -- freedom to explore and challenge. Science is necessarily quantitative, and crudely expressed, rests on setting up a testable hypothesis, testing it quantitatively and then accepting, revising or discarding an hypothesis as a result of all relevant and correct experimental results.

That is the scientific method. It has been extremely successful in explaining the material universe. It has helped lengthen the human lifespan by preventing premature death from natural hazards like disease, weather catastrophes, crop failure and starvation.

The attendant societal benefits that sometimes arise from scientific progress can require skepticism that conflicts with authority. Two examples from history are reminders: (1) mass witch trials and executions in the late 16th and early 17th century in Europe; and (2) the early 19th century's high deathrate of women from childbed fever in America and Europe.

(1) Mass witch trials in Europe -- Trials, torture and executions (whose details are too bitter to recount) for sorcery had never been so numerous as they became in the late 16th century, especially in central Europe. The Late Middle Ages rolled through chaotic upheaval in Europe, including deterioration of climate of Europe into the prolonged period labeled the Little Ice Age to poorer agricultural conditions beginning around the 13th – 14th century. Farms and towns were abandoned, especially at higher elevations or latitudes; pasture area was reduced by the growth of bogs. Secular and religious governments clashed in titanic efforts to claim authority. Black Plague swept in from Asia to Genoa in 1347 and killed in less than five years approximately 30% of the population of Europe. War, starvation, disease and death struck European societies.

The harsh and irregular climate of Europe's Little Ice Age worsened to its extreme in the period ca. 1550 - 1700. Crop failure, price shocks, starvation, famine and disease occurred as a result of unusually intense hailstorms, late spring or early fall frosts and frequent floods, for which much evidence has been recently found. Demanding cause and effect, the myth-filled human mind, amidst the turmoil of societal upheaval and superstitious belief people who had the power to order natural disasters, had to fix blame and issue remedy.

Historians, studying newly accessible court records, have revolutionized ideas about the causes of the mass witch trials. Improved estimates have been made of the number of victims -- probably on the order of 10,000 people across Europe were mainly burned at the stake. Accusations was prevalent in rural areas, especially in parts of Germany;. secular Catholic and Protestant authorities actively acceded to public demands for “justice” from sorcery. Historian Wolfgang Behringer (1995, p. 7) quotes a diarist from Trier who explained the popular belief in malevolently designed weather catastrophes as one factor in the period's mass trials: “Because everyone generally believed that crop failures over many years had been brought on by witches and malefactors out of devilish hatred, the whole land rose up to exterminate them.”

Behringer (2002) gives gives several examples of “weathercooking” – the ludicrous myth that people could create weather disasters through sorcery. One mass trial arose from the “unnatural” (in the impression of contemporary diarists) severe late frost of May 27, 1626 that destroyed vineyards and crops. In the town of Zeil a chronicler wrote, “As a result [of subsequent price shocks from crop failure] pleading and begging began among the rabble, questioning why the authorities continued to tolerate the witches and sorcerers destruction of the crops...” Behringer reports the response: 600 victims killed in Bamberg, 900 in Würzburg, 900 in Elector Mainz and nearly 2000 in Westphalia over the next several years.

The sorcery trials were brought to an end by improvement in intellectual and legal institutions and the development of early meteorology. Treatises began to appear in the early 16th century that challenged the consensus by sweeping away weathercooking and arguing natural causes for poor weather.

(2) 19th century childbed fever -- Rather than deliver their babies at the clinic in Vienna where the death rate from childbed fever was approximately 25%, women preferred to reduce their chance of death by giving birth outside the clinic -- even in the streets littered with horse manure. A physician at the clinic, Ignaz Semmelweis, suspected that doctors carried a contagion from cadavers to women in birth that caused childbed fever. Semmelweis suggested that doctors cleanse their hands between tasks, and when they did the incidence of childbed fever dropped dramatically.

In the United States, Prof. Oliver Wendell Holmes (essayist and father of the Supreme Court jurist of the same name) independently discovered a similar remediation for cases of childbed fever, which he tracked and published in a detailed paper in 1843.

Both physicians challenged the consensus in the medical community. Although the theory of microbial disease still awaited its development by the first bacteriologist Robert Koch and chemist Louis Pasteur, both Semmelweis and Holmes had found effective means of prevention. A later scene from a lecture in 1879 at L'Academie de Medicine in Paris described by the National Health Museum shows the power of consensus despite amassed evidence supporting Pasteur and Koch's germ theory of disease. After an eminent physician deprecated hand disinfection as a way to prevent disease carried to mothers giving birth, Pasteur rose from the audience to admonish him: "The thing that kills women with [childbirth fever]..is you doctors that carry deadly microbes from sick women to healthy ones."

Two brief examples out of many in the unlit, past frontiers of scientific knowledge show how science has brought understanding of nature, and how institutional, legal and societal support of the process of science has improved the health and welfare of humankind and the environment. Deep gratitude is owed to those who defend and support the freedoms underlying science: To Members of this Committee and your Colleagues: thank you.

"Everything was in question; everything seemed inexplicable; everything was doubtful. Only the large number of deaths was an unquestionable reality."

-Ignaz Semmelweis, "The Etiology, Concept and Phophylaxis of Childbed Fever" 1861

"This long catalogue of melancholy histories assumes a still darker aspect when we remember how kindly nature deals with the parturient female, when she is not immersed in the virulent atmosphere of an impute lying-in hospital, or poisoned in her chamber by the unsuspected breath of contagion."

-Oliver Wendell Holmes, "Contagiousness of Puerperal Fever" 1843

Selected reading and references

T. Alm 2003, The witch trials of Finnmark, Northern Norway, during the 17th century: Evidence for Ergotism as a contributing factor, *Economic Botany* 57(3), 403-416

Wolfgang Behringer 1995, Weather, hunger and fear: Origins of the European witch-hunts in climate, society and mentality, *German History*, 13 (1), 1-27

Wolfgang Behringer 1997 *Witchcraft Persecutions in Bavaria*, translated by J. C. Grayson and David Lederer, Cambridge University Press, 476pp

Wolfgang Behringer 2002 Climatic change and witch-hunting, at University of York, website <http://www.york.ac.uk/depts/hist/staff/wmb1> accessed August 3, 2002

V. Gordon Childe 2003 (reprint of 1936 book) *Man Makes Himself*, Spokesman, 244pp.

Gerald Holton 1988 *Thematic Origins of Scientific Thought: Kepler to Einstein*, Harvard University Press, 499pp

Alan Charles Kors and Edward Peters (rev. Edward Peters), ed. 2001 *Witchcraft in Europe, 400-1700, A Documentary History*, University of Pennsylvania Press, 451pp

Hubert H. Lamb 1985 *Climatic History and the Future*, Princeton University Press, 835pp

E. W. Monter 1971 Witchcraft in Geneva, 1537-1662, *Journal of Modern History*, 43, 179-204

Karl R. Popper 1959 *The Logic of Scientific Discovery*, Basic Books, 480pp

R. Zguta 1977 Witchcraft trials in Seventeenth-century Russia, *The American Historical Review*, 82 (5) 1187-1207

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