

CLASSICAL DEMOCRACY AND SCIENTIFIC EXPERTISE

Roald Hoffmann

Over 2,500 years ago, in a feat of proto-chemistry, a beautiful blue dye was laboriously and ingeniously extracted from several species of Mediterranean gastropod snails. The dye was known in the classical world as Tyrian or royal purple, and to the Israelites, for whom it had a ritual function, as *tekhelet*, used to dye a strand of the fringes of their garments blue. A very similar molecule, indigo, was available from two plant sources: the indigo plant of the pea family, and woad. In time, as chemistry developed, the synthesis of the dye was achieved in 1880 in Germany. Now it is produced in sufficient quantities to dye inexpensively the untold millions of pairs of the proletarian and elite costume of our times, that most important contribution of the United States to world sartorial culture: blue jeans.

Useful things, old and new, are the stuff not only of science, but also of society. In between the Tyrian-purple protochemistry and our time, an old social idea, democracy, grew into the souls of people. The notion was that men (and God knows, it took 2,400 years to see that women have that prerogative, too) have the right to govern themselves. The idea was that the social contract implied a given equality at the beginning, so that if human beings live together, the legitimacy of their actions, delegated in some way if need be, stems ultimately from themselves and not from a master or czar or party secretary or ayatollah.

It is worthwhile to reflect on democracy in this time, 2,500 years after Cleisthenes' reforms in Athens (the historical marker generally accepted as the institution of Greek democracy), 20 years after a return of democracy to that beautiful and ancient land of Greece. I want to look at this social invention, democracy—as much the work of men

and women as synthetic indigo or the 10¹¹ pounds of sulfuric acid made every year—in the context of its interaction with science and technology.

The basic content of classical Athenian democracy was clear, even as its radicalism varied. The polity granted to all citizens the right to be heard and to participate in making decisions. True, women, slaves and that interesting category of resident aliens, the *metics*, were excluded. But we must not ask too much, to hold the past up to today's standards. The city-state also demanded, in return, service, to a degree unparalleled since. Much of that service was in the political sphere. The Athenian democracy was participatory, in the oral or spoken sense, and all-embracing of its citizens. Imagine that in a city of 17,000 citizens, a jury voted on the guilt of Socrates by a vote of 280 to 220! And it wasn't the only jury (*dikasteria*) proceeding that day! Nine others might have been under way at the same time.

Trust in the people, a separation of the public (*to koinon*) and private (*to idion*) spheres, a social contract between the individual and the state—all these are the lasting contributions of the Greek democracy. That democracy, in its classical Athenian form, did not survive, that the idea had to return, and not only once, reflects that unremitting struggle between forms of government, between democracy, oligarchy and tyranny. That contention continues and has meaning in our time.

How might have classical democratic Athens dealt with the environmental concerns of our time? There is no question that the matter of a potential public danger, justifiable or not, would have been a subject that the *ekklesia* (the general assembly of citizens) would discuss. The participatory political process ensured this. Pericles' funeral oration, as reported by Thucydides, summarizes the essence of the process, and moves us to the connection with science. He says:

...our ordinary citizens, though occupied with the pursuits of industry, are still fair judges of public matters; for, we alone regard the man who takes no part in public affairs not

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Figure 1. Athenian tetradrachm, made of fine silver, circa 440 B.C.E. (Courtesy of Sotheby's.)

as one who minds his own business but as good for nothing. We Athenians are able to judge all events, and instead of looking on discussion as a stumbling block in the way of action, we think it an indispensable preliminary to any wise action at all.

It is clear that the citizens of the city-states of Greece felt themselves able to judge, no matter how technical the matter. They gave a place to expertise, to be sure. So military officers, such as the *strategos*, were elected (rather than selected by lot, the typical way of assigning tasks in Greek democracy). The military commanders could hold the office repeatedly. And many, such as Pericles, did.

It is interesting to look in the ancient records for attitudes toward science and wisdom. Given the strong technological basis of the success of the Athenian state, its military strategy, weapons, the fast *triremes*, its great silver mines at Laurion, one might have expected more than I, at least, was able to find. In Aristotle's *Constitution of Athens* one does see mention of contracts to work the mines, leases for the same. These are under the *poletai*, picked by lot from the tribes. There are inspectors of weights and measures, also picked by lot. We have lists of the mining leases, and know the appalling working conditions of the miners. We even have a record of an intriguing, in the modern context, proposal by Xenophon to nationalize the privately owned labor force of slaves that worked the Laurion mines.

Athenian silver was won in two ways. Sometimes it came from alluvial white gold, an alloy of gold, silver and other metals. More commonly,

as at Laurion, it occurred in deposits with the lead sulfide, galena. The ore was sorted and concentrated using an ingenious hydraulic system, roasted and the oxide reduced with charcoal. The crude silver, or lead-and-silver alloy, was then subjected to cupellation. This is an ancient process in which an ore is heated with lead in a vessel shaped of bone-ash and earth. A blast of air oxidizes the nonprecious metals; the base metal oxides dissolve in the lead oxide, which floats on top and is skimmed off. The precious metals, here silver, remain behind.

In another place, another time, the prophet Jeremiah, who knew a lot of metallurgy, uses cupellation as a metaphor:

I have made you an assayer of my people
—A refiner—
You are to note and assay their ways.
They are bronze and iron
They are all stubbornly defiant;
They deal basely
All of them act corruptly.
The bellows puff;
The lead is consumed by fire.
Yet the smelter smelts to no purpose—
The dross is not separated out.
They are called "rejected silver,"
For the Lord has rejected them.

The matter of ships, the *triremes* that gave Athens its naval power, was a subject of direct interest to the people. The *boule* (the appointed senate-like body) builds new ships, but the people in the *ekklesia* vote to construct them. The people elect the naval architects for the ships, so this is a position of great importance, not selected by lot. I do not know if the naval architects could be re-elected, as were the *stratego*i.

But there is little else. Perhaps this is because the records have not survived, or it is conceivable that my search for public attitudes toward science in the old Athens is in vain, because much of education, industry, agriculture and trade, therefore technology, was not a political matter, but left to private enterprise, not debated in the public assemblies.

There is that indelible stain on democracy, the trial of Socrates. Although the final verdict was in part provoked by the philosopher's almost arrogant intransigence, the prosecution itself burns on our conscience. Here is a seeker after wisdom, a questioner if not a scientist, a prophet, silenced by the people. Not by one tyrant, but by 280 of his fellow citizens. No wonder that his followers, Plato and Aristotle, looked unkindly on democracy, and favored a government of philosopher-kings, of experts. Often scientists join in their dream. But that is just that, only a dream. Speaking for myself, I would not like scientists and engineers to run this world.

I want to salute the ancient Greeks not only for their philosophy, art and literature, but also for their ability to devise ingenious social structures that truly gave citizens the sense of being

empowered. The large juries, the rapid rotation of offices by lot—all of these kept everyone involved. Some of the Athenian inventions that have lapsed need to be revived—for instance, the *euthuna*, the standard and detailed investigation of an office holder's conduct at the end of his term of office. It was and is a wonderful idea, and it would be good to have it become a routine process for anyone who might profit in power or wealth from his or her position.

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