Female lions share a common resource, the territory; but only a proportion of females pay the full costs of territorial defense. If too few females accept the responsibilities of leadership, the territory will be lost. If enough females cooperate to defend the range, their territory is maintained, but their collective effort is vulnerable to abuse by their companions. Leaders do not gain "additional benefits" from leading, but they do provide an opportunity for laggards to gain a free ride.

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Treatment of Chronic Lyme Disease

Eliot Marshall's News & Comment article "NIH gears up to test a hotly disputed theory" (13 Oct., p. 228) and several statements in a subsequent letter by Peter McFadden (1 Dec., p. 1419) require comment. At issue, according to Marshall, is whether there is a chronic form of Lyme disease that sometimes persists after a course of conventional antibiotics has been given.

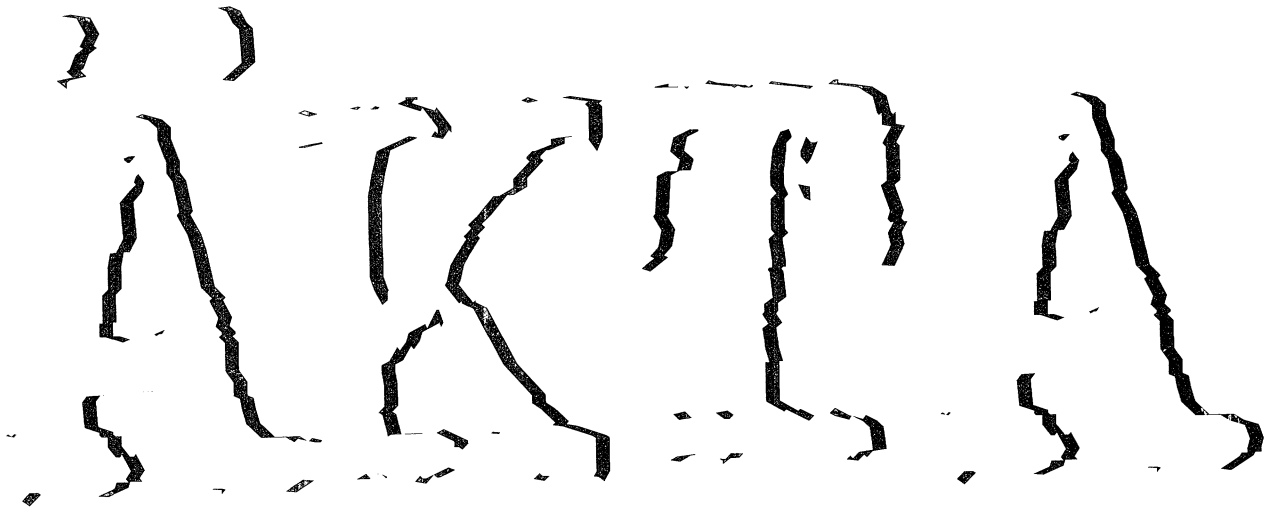
When my colleagues and I recognized Lyme disease as a separate entity in 1975 (*1*), we were fully aware of the medical literature about three entities that had been loosely linked with one another in Europe: an expanding skin lesion called erythema chronicum migrans (*2*), an atrophic skin condition called acrodermatitis chronica atrophicans (*3*), and a neurologic syndrome called Bannwarth's syndrome (*4*). However, in Europe, these syndromes had not been associated with arthritis, and it was not clear whether the European experience could be extrapolated to the multisystem illness that we were studying in the United States.

After our early reports about erythema migrans and Lyme arthritis (*5*), my colleagues and I described other features of the illness, including cardiac, eye, and acute and chronic neurologic manifestations (*6, 7*). I thus fully recognize that Lyme disease is a chronic, multisystem illness that may occur in active or latent forms over a period of years.

I was originally skeptical of the role of antibiotics in treating Lyme disease, and my early articles reflect this point of view. However, controlled studies had not yet been done in Europe when I wrote those articles, and my colleagues and I proceeded to do them (*8*). They were begun before the causative agent was known and played a major part in establishing the role of antibiotics in the treatment of this infection.

Treatment failures may occur with short-term antibiotic regimens (2 to 4 weeks orally or 4 weeks intravenously), and retreatment may be necessary (*9*), but there is no convincing evidence that courses of antibiotics for many months are of benefit in the treatment of Lyme disease, and such therapy has a significant risk of side effects (*10*).

There are many explanations, only one of which is active, ongoing infection (*11*), for persistent symptoms after standard courses of antibiotics have been given to patients with Lyme disease. Patients with chronic neuroborreliosis may have persistent spirochetal infection in the brain after



standard courses of antibiotics, but some symptoms may remain because of residual damage from past infection (*7*). Joint inflammation may persist for months or even several years after the apparent eradication of the spirochete from the joint with antibiotics, possibly because of immune-mediated phenomena (*12*). It is likely that *Borrelia burgdorferi* infection may also trigger para-infectious pain or fatigue syndromes, which may persist indefinitely after eradication of the spirochete with antibiotics (*13*).

The most common reason for persistent symptoms after standard courses of antibiotics in patients with suspected Lyme disease is misdiagnosis (*14, 15*). Of 788 patients referred to our clinic with a presumptive diagnosis of chronic Lyme disease, we thought that 23% had active Lyme disease; 20% had previous Lyme disease and another current illness, most commonly chronic fatigue syndrome or fibromyalgia; and 57% did not have Lyme disease; they also most commonly had fatigue or pain syndromes (*14*).

The Centers for Disease Control and Prevention (CDC) has developed objective clinical and laboratory criteria for the diagnosis of Lyme disease for surveillance purposes (*16*). As with any nationwide reporting system that depends on passive surveillance, there is surely underreporting of cases. From epidemiologic studies, it is clear that Lyme disease is spreading (*17*); it has caused focal epidemics in the northeastern United States (*18*), and it is now the most common vector-borne disease in the country (*19*).

Regarding Marshall's quote of my saying that "the multimillion dollar trial that the NIH [National Institutes of Health] is planning would never have been funded through normal mechanisms," I believe it would be more correct to say that such a trial would never have been funded through the normal RO1 mechanisms of investigator-initiated research. However, NIH sometimes uses other mechanisms to fund research on complex clinical questions, one of which is multicenter study groups. I support the decision of NIH to put together such a group to study questions about chronic Lyme disease. A similar kind of group formed by the CDC has been invaluable in addressing problems concerning serologic testing in Lyme disease (*20*). For the NIH group, the challenge will be the study design. The number of patients who meet objective criteria for chronic neuroborreliosis is small, which makes patient accrual difficult. More patients have nonspecific symptoms, such as disabling muscle pain, fatigue, or memory difficulty, after having Lyme disease, but measurement of the treatment response may be difficult in this group. Nevertheless, I am confident that a well-designed, multicenter examination of chronic Lyme disease will provide valuable new insights into this complex infection.

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Effective U.S. Science Continued

The depiction by Radford Byerly Jr. and Roger A. Pielke Jr. of the ecology of U.S. science (Policy Forum, 15 Sept., p. 1531; see also Letters, 22 Dec., p. 1906) is flawed both as history and as policy prescription.

Vannevar Bush's famous report, *Science: The Endless Frontier* (*1*), was written during the last stages of World War II and thus can hardly be equated with the environment for science later created by the Cold War. In fact, the Bush report was never implemented. Instead of the "national research foundation" Bush advocated, defense research remained with the armed services, medical research was placed with the National Institutes of Health, and research on atomic energy was confided to the Atomic Energy Commission (*2*). And so it has been for 50 years. These mission agencies have been supported by democratically elected representatives because of their contribution to social goals (national defense, health, and energy) and thus meet Byerly and Pielke's prescriptions for a "new" science policy. All the mission agencies together account for 97% of federal research and development funds—85% of federal funding for basic research (*3*).

The National Science Foundation (NSF) was created in 1950 on President Truman's terms, not Bush's—that is, it was accountable to the President rather than to scientists. It did not receive substantial funding until the 1960s and subsequently was called on to further social goals like science education and economic competitiveness. NSF nevertheless champions the role of supporting investigator-initiated research meant to advance scientific knowledge. It thus stands as the only conceivable target for Byerly and Pielke's caricature of the "Bush contract." The implication is that this comparatively small island of disinterested research support should be sacrificed to a new standard of "problem resolution."

If Byerly and Pielke believe that science can resolve the problems they specifically mention—"racism, drug abuse, breakdown of community, and crime"—they might ponder the history of the 1960's Great Society programs. Their recommendation for a national debate to achieve democratic accountability (besides begging the questions To whom? In what time frame?) similarly misrepresents what science can and cannot accomplish.

There is some validity to the contention of Byerly and Pielke that metaphor, or ideology (*2*), influences thinking about science. In the 1960s, when academic science better resembled what is indicated in the Policy Forum, research was uncritically enlisted in our "race" with the Soviets. However, the 1970s demanded social relevance from science, as in the dubious "War on Cancer." In the 1980s, science again prospered under the overriding image of technology transfer (*2*). In this decade, though, Byerly and Pielke invoke a spurious "political ecology" to rationalize reduced federal support for science.

The expenditure of public funds for science cannot claim exemption from scrutiny or evaluation, but it is dangerous to suggest that our society might choose to support only "useful" science.

A more valid ecology of U.S. science might start from the fact that the world's most productive scientific community exists within the world's most robust total economy. The notion that such a science- and technology-based economy can be maintained in the long run with a smaller investment in research is the assumption that should be "critically examined." Those who argue that the complex process of scientific inquiry can be bypassed in favor of immediate "problem resolution" or "measurable results" might well consider the fate of the goose that laid the golden eggs.

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Response: Geiger is correct in his assertion that "the Bush report was never implemented." However, as Donald Stokes has noted, "Bush's organizational plan was defeated while his ideology triumphed" (*1*). It is Bush's ideology, what we called the "social