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SYMPOSIUM

Panglobalism and Pandemics: Ecological and Ethical Concerns

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A pandemic is a human medical problem but must be understood at multiple levels. Analysis of social and commercial forces is vital, and, more comprehensively, an ecological framework is necessary for an inclusive picture. Ecological health webworked with political and social determinants surrounds issues of human health. In this constellation of both natural and social factors, ethical concerns will arise at these multiple levels, from human health to the conservation and health of wild nature.

1. INTER-CONTINENTAL INVASIVES: ECOLOGICAL AND HUMAN HEALTH

One of the classical proverbs of ecologists is that everything is connected to everything else. Though something of an overstatement, this proverb is true often enough to bear recalling. Increasingly, for better or for worse, it is proving true with links between ecological and human health, links that tie local to global events, in both nature and culture. We, start first with invasives, of which pandemic pathogens are a subset.

Other species increasingly exploit human capacities for world travel and trade, often to become invasive and disruptive of ecosystems. Exotic plants, especially those r-selected in their native habitats, can have characteristics that make them weedy, rapidly multiplying on the disturbed soils of civilization [1-3]. Similarly, exotic insects, microbes, and fungi can become pathogens in native plants at levels that make them, in effect, pandemics [4]. Anticipating new pandemics that threaten human health, we should consider parallels in natural ecosystems.

The balsam woolly adelgid *(Adelges piceae)*, which co-exists more or less peacefully with the silver fir in Europe, was accidentally brought to New England on nursery stock. It reached the southern Appalachians in the 1960s and in three decades decimated the Fraser fir *(Abies fraseri)*. The pathogen has killed 95 percent of the mature trees in the Great

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† Abbreviations: BSE, bovine spongiform encephalopathy; MBM, meat and bone meal.
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Smoky Mountains National Park, which contained three-quarters of the spruce-fir forest in the southern United States. There may be as many as 50,000 adelgids on a single tree. The fir trees are also stressed by airborne pollutants, which compounds the epidemic [5].

More recently, the hemlock woolly adelgid *(Adelges tsugae)*, from Asia, has now appeared and threatens to become pandemic on Eastern hemlock, posing the greatest threat to Eastern forests since the chestnut blight.

Foreign viruses and microbes that land in New York or Los Angeles are similarly invasive, except that they upset human health in cities, rather than the health of the land [6]. Against a constant background of common infections, epidemics have periodically emerged over the course of civilization, as with the Black Death of the 14th century. These potential pathogens were once rather limited by distances, since few of them are highly mobile on their own. They often remained local or regional.

But humans now provide transportation by jet plane or ocean freighter halfway around the globe in a few hours or days. Often the spread of a pandemic can be traced from airline hub to airline hub [7, p. 245]. Although foreign viruses and microbes are not highly mobile on their own, many of them did evolve to travel on birds, which are highly mobile [8-10]. That suggests a connection between birds, especially waterfowl, and the microbes' capacity to travel on our jet planes. These microbes evolved to do well on hosts that fly great distances. The West Nile virus infects more than 30 North American mosquito species, which together transmit the infection to at least 150 bird species, many of which migrate [11].

Such pathenogenic invasives also often prove to be opportunists in moving from the birds and animals in which they formerly co-existed as parasites over millennia to the human populations, which become their new environment. The 1918 flu epidemic that killed 40 million people is known to have originated in birds [12]. Further, as we next see, the contagion escalates with crowding, both of animals and of people. Pathenogenic microbes can evolve rapidly (much more rapidly than plant invasives) and are quite versatile. In their former ecologies, there had been time for co-evolution between parasite and host, often producing non-pathological coexistence and not infrequently symbiotic relations [13]. Even in humans, most internal microfauna is harmless. But exposure to novel pathogens can prove as hazardous to humans as adelgids are to fir.

Globalism sets up atypical ecological conditions favorable for invasives and pathogens alike. The result is human disease, but the inclusive framework is social upset of ecologies. When we disturb landscapes, we invite species that become weedy, and hence the escalating problem of invasive species. With epidemic and pandemic diseases, there is a parallel process at the microscopic level. We disturb the ecology, and the microfauna, too, become (so-to-speak) "weedy," especially the pathogenic ones. In fact, the parallel processes are often linked, from ecosystem to microbial scales, global to local [14].

The 1998-1999 Malaysian Nipah virus epidemic emerged when pigs (raised for international trade) were crammed together in pens located in or near orchards. The orchards attracted fruit bats whose normal habitats had been disrupted by deforestation; their droppings contained the as yet unknown paramyxovirus and infected the pigs. The overcrowding led to explosive transmission rates and to infections in pig handlers. So a virus that was once not disruptively epidemic became so because of human disruptions of natural habitats of bats and overcrowding of pigs, driven by global commercial interests. The Malaysian government culled over 1 million pigs [7, p. 243; 15]. The ecological upset from deforestation

proved to be linked with novel human pathogens and the threat of transporting such disease globally. The bats are also sold in markets in China to be eaten and used in traditional medicine. When the human health problem is so tied into forest ecosystems, stressed by global trade in timber, complicated by global meat markets, any analysis will be inadequate that sees the problem as a virus in the bats.

More recent examples are SARS and avian flu in Asia, Ebola in Africa, and the continuing spread of BSE[†] (bovine spongiform encephalopathy, which may cause Creutzfeldt-Jacob disease) through Europe and later North America. As we see in more detail below, these diseases share a worrisome characteristic, their capacity to cross the Darwinian divide between animals and people, and this is favored by the disruption of the ecosystems in which they evolved. They are opportunists at exploiting rapid transportation, stressed under the pressures of global trade.

The larger framework, suggest two veterinarians at the Wildlife Conservation Society, requires thinking holistically "based on the understanding that there is only one world — and only one health" [16, p. 50]. That links conservation concerns and medical concerns, in what is now called "conservation medicine" [17]. "Health effects ripple throughout the web of life. Health connects all species" [18, p. 9]. Human health requires thinking in ecological contexts, increasingly in more global ones. This further suggests more inclusive ethical concerns: Global, international, and interspecific, beyond the immediate protection of human individuals from disease. Developed countries, which may have thought themselves protected with their high technologies and advanced medical systems, discover they are still linked with health, human and animal, to the developing world, even to wild nature, and vulnerable to disruptions there, to which they may also be contributing.

2. ESCALATING CHANGES VERSUS GLOBAL PRECAUTION

The more massive the manipulative power, the nearer industry and agriculture approach the carrying capacity of the commons, the more the unintended, amplifying consequences are likely to be far reaching. When the first New England settlers set about to build a new world culture, their Yankee ingenuity in farming and business posed little threat to the ozone layer, about which they knew nothing. Twentieth century manufacturers of aerosol fluorocarbons have endangered that protective layer. Early Virginia farmers hardly knew that the South Pole existed; modern agribusiness in the South can use DDT that makes its way into penguins in Antarctica. This escalating power to introduce changes at global levels shifts the burden of proof and increases the burden of precaution. When the possible adverse results of introducing the change are more irreversible than not doing it, the burden of proof shifts to those who wish to introduce changes.

Increasingly, the social, political, and commercial forces driving globalism are inadequately related to the determinant biological forces, from global biosphere levels to microbial levels [14, 16, 17]. One might have hoped that as human technological, industrial, agricultural, and medical competence increased, risks would diminish. Food safety inside developed nations has increased, for instance. Yet as the depth of upset advances even more, across the spectrum from global to microbial processes, there are unintended consequences that accompany the intended consequences.

Human power to produce changes increasingly overshoots human power to foresee all the results of these changes. The latter takes much more knowledge. Chemists knew how to make Kepone but were unable to predict what it would do in the ecology of the James River estuary

[19, 20]. Geophysicists could mine uranium and make reactors but could not predict where the mutagens in the tailings would end up and what biological damage would result in wildlife and in humans [21]. Such chemists and engineers might be lucky, but often not. Serendipity is rare in highly manipulative technology.

The United Kingdom BSE Inquiry Report to the House of Commons concluded that those who authorized feeding cattle recycled meat and bone meal (MBM) remains from sheep and cattle ought to have anticipated trouble with the effort "to turn grass-eaters into cannibals," feeding them food that cattle did not evolve to eat. They ask "why those responsible for the practice of using MBM in cattle feed did not foresee that this might be a recipe for disaster." "What went wrong was that no one foresaw the possibility of the entry into the animal feed cycle of a lethal agent far more virulent than the conventional viral and bacterial pathogens, and one which would be capable of infecting cattle despite passing through the rendering process" [22, vol 1, p. 226-227]. To put this bluntly: If you try to make carnivores out of herbivores, you can expect upsetting surprises.

Agribusiness can build battery farms and raise 100,000 chickens in dense space, aware of the needed nutrients and antibiotics to keep the chickens marketable but has proved unable to predict what pathogens would infect the chickens when and where. In developing nations, this may depend on the extent to which chickens are exposed to wild birds in markets, including the illegal trade in wild birds, which may extend to developed nations. In October 2004, avian flu (H5N1 type A virus) was found in two crested hawk-eagles that were smuggled from Bangkok into Brussels in an air traveler's carry-on baggage, destined for a Belgian falconer [23].

In complex systems, blending social and biological forces, at global to microbial ranges, disrupting evolutionary ecosystems, introducing rapid changes, driven by commercial interests, ignorance is likely to outpace knowledge. Outcome is often quite different from intent. One ought increasingly to slow down the introduction of potentially more potent novel changes with adequate precaution and pretesting. The unforeseen consequences outnumber the foreseen consequences, and the bad unforeseen consequences outnumber the good unforeseen consequences, especially when one is massively upsetting ecosystems and massively moving organisms around on the globe, both those that humans intend to move (legally and illegally, chickens and the hawk-eagles) and those they do not (the flu virus).

Precaution is demanded but, with such complex interconnections, permitting the trade under what is hoped to be sufficient precaution is at times unrealistic. The global surveillance system is incompetent for such oversight. Once again, economic and political factors mix with biological monitoring, as often to prevent as to facilitate collaboration. Agencies responsible for human health differ from those responsible for livestock health; often there is no agency charged with monitoring wildlife health [24]. There are frequent "institutional or diplomatic constraints that do not permit the dissemination of critically important 'unconfirmed' information on disease outbreaks" [25, p. 983]. There are documented delays as long as seven weeks between recognition of pathogens and international reporting [26]. In view of the "just-in-time" delivery system (see below), millions of animals will have been transported in this period.

The needed surveillance is likely to be institutionally impossible in developing nations with meager health care resources, where outbreaks often start. Developing nations may have no such systems in place; international organizations no authority to intervene. Under agreement with member states, the World Animal

Health Organization cannot accept information on wildlife diseases unless such information has been sanctioned by a national agricultural authority, which may not have such expertise [16, p. 50].

Developed nations monitor livestock and food commerce within their borders, but not overseas origins, which is not within their jurisdiction. Agencies have to respect national borders; pathogens do not. Surveillance, domestic or international, is piecemeal; nobody has this scope of vision or authority. "No organization has the mandate to pursue policies based on a simple but critically important concept: that the health of people, animals, and the environment in which we live are all inextricably linked" [16, p. 39].

This situation is likely to generate mismatches between free-market economics and the biology of pathogens. Economists do not tend to think biologically. Those who are pushing to develop the economy, to exploit new markets and new products, do not have a precautionary mindset. Of course there will be the usual assurances of improved surveillance, tighter regulations, and more rigorous safety inspections. This will increase the bureaucracy. Especially when there is alarm, no one in government agencies in charge of food or medical safety wishes to admit they cannot improve control and surveillance [22]. Meanwhile, the drive to maximize profits continues.

Despite the U.K. experience, the U.S. Food and Drug Administration, though it has proposed some prohibitions, particularly of brain and spinal materials, still permits feeding animal proteins to livestock. The FDA and the meat industry remain "totally committed to continuing the practice of feeding slaughterhouse waste to cows." A ban on feeding all animal protein to livestock, an FDA spokesperson says, would be "a big expense for the industry." This comes, of course, with simultaneous FDA reassurances that the new prohibitions will "remove 90 percent of potentially infectious matter from all animal feed" and that this "reduces a very, very low risk even lower" [27]. Remembering how, as one critical summary of the U.K.'s Phillips report put it, the cattle were fed the animal protein, the "nation fed a diet of reassurances" [28], one wonders whether to trust the experts and, if they are right, whether low, low risk of a pandemic disease is acceptable.

Dealing with the possibility of introducing new diseases, one might have hoped that what one ought to do will coincide with what one should prudently do. This has proved so with culling after diseases are found and a threat becomes high profile. The Malaysian government culled more than 1 million pigs to stop the Nipah virus. Efforts to control the spread of avian influenza in Asia have required culling more than 140 million chickens. But there are factors that decouple the two.

In addition to the difficulty of prediction, there is likely to be a lag time; the intended consequences of changes will be immediate and obvious; the unintended consequences do not show up for five or 10 years. The latency period for BSE, for example, is typically five years and initially strikes a single cow in a herd [22, vol 1, p. 20]. When pathogens begin to be suspected, what is going on is initially difficult to find out. Masked palm civets were first thought to be the reservoir of the SARS coronavirus; now the reservoir seems to be bats [15]. The role of migrating wild birds in the transmission of avian influenza compared with that of commercially transported chickens is under debate [23]. By the time researchers can prove the transmission routes, in both ecosystems and world trade, the pathogen is already widely present. The harm is likely to be done in another region, probably another nation, from that where the initial care needs to be exercised. Predictions are the more unreliable and suspect because there is little previous experience. The organ-

isms are new pathogens in new environments. Such factors make adequate precaution increasingly unlikely in times of escalating change. Again, this suggests increasing ethical concern.

3. CAPITALIST OVERSHOOT AND SYSTEMIC OVERSTRESS

There is a momentum in capitalism that tends to overshoot. In any comprehensive view of sustaining health, from ecosystems to microbes, wild nature to human society, one has to factor in a capitalist tendency to overshoot. Capitalists want to operate, as economists say, "at the margin." Although in commerce that has a technical meaning, it also means that capitalists will stress the limits of their productive systems. Trouble is likely even when engineers operate technical systems at the edges of their capacities, though the specifics are unpredictable. Think of the brownouts and blackouts in overloaded electricity grids, when some unexpected voltage surge does not trip but blows a safety switch and this triggers system failure.

When commerce encounters ecosystems, there is more of this more risky operating "at the margin." Capitalist systems will push natural systems to their limits. One always hopes for a better crop this year, with a better seed and new fertilizer. One hopes for a better fishing season, with bigger nets and better electronic gear. When there is a run of good years, the producers expand, buy more land, tractors, and new fishing boats, and get ready for another good year. But then comes a run of dry seasons, bad fishing seasons. The business operators cry for help. The government intervenes to subsidize, adjusts interests rates, changes tax rates, lest companies fold, jobs be lost, and the economy take a down turn. The push is as much to sustain profits as to sustain ecosystems [29-31].

That pressure, generic to capitalism, amplifies the risks when applied to animal and human health, especially in the global food trade. Retailers and manufacturers seek their products and raw materials where they are cheapest, and that is not likely to be where health safeguards are maintained. The food trade has increasingly developed a "just-in-time" network of delivery to the supermarket chains [32]. Consumers want their bananas ripe and tasty, and this requires delivering them to the supermarket "just-in-time," else they are too green or too full of black sugar spots to delight the customer. Likewise with fresh meat and produce flown across oceans and delivered the day before it is sold. The customer is satisfied; the wholesaler saves cost of inventory and warehousing. But this will stress inspection systems that need time to be more cautious.

Combine that with maximally profitable sales "at the margin," and the food delivery system is likely to overshoot the productive capacities of agricultural systems and to discount safety measures, perhaps in ignorance of the increased risks. This will be all the more true with unseen microbial diseases and their vectors, with a lag time of several years before becoming symptomatically evident.

Many persons in business are paid to introduce changes and new products, the quicker the better. But few are employed to foresee adverse consequences and caution against them. Some economists are conservative; they take care to hedge their bets. There is much talk of "sustainability." At the same time, in the market system there is little pay attached to conservative care, nor to rational consideration of the best social options. There is no pay at all attached to the defensive appreciation of nature, although in these low-pay and no-pay areas there is much at risk and much of value to be defended. Checking these economic pressures, a role of government is to regulate and widen by law the margin of safety and to assure the preservation of environmental values. Caution is not only prudent but a moral requirement in these circumstances.

But, as we have seen, there is often reason to doubt whether the governmental authorities have the expertise or resources to deal with these kinds of problems early on. Early warnings of caution will generate conflicts of interest. Governmental authorities who deal with the problem will be closely connected to the financial interests threatened [22, 28]. Politicians desire a booming economy just as much as economists. Inside industry, no one wants bad news, certainly not managers and stockholders, and also not labor and customers. There will be some tendency to suppress or delay, or disbelieve the warning signs. There is an institutional tendency for bad news, discovered or suspected down in the shop or out in the field, to be suppressed as it rises up the institutional hierarchy. The bad seal on NASA's Challenger 7 is a famous example [33].

Recognizing such systemic stresses and biases, especially as these involve pandemic threats, it becomes more important than ever to err on the safe side. A critic here might reply that this tendency to overshoot may be true in the broad market sector, but is not true in health care, whether in medicine or pharmaceuticals. The usual complaint is the other way around: government regulations prescribe such a host of precautionary tests that it is difficult to introduce a new drug on the market. The regulating authorities are quite conservative. Here many people are paid to be cautious. In health care, practitioners and suppliers are afraid of lawsuits if they are not cautious.

But this care does not readily transfer to the production of human food, or to the commercial process that moves exotics around. In the "just-in-time" delivery system, stressed animals, some of whom have traveled long distances, will be more susceptible to such diseases, and these stressed animals are likely to be mixed in pens and batteries with local and healthy animals. Consumer desires for cheap and tasty food override caution and care in production [34]. The pressure to keep cows in calf will add more stress. At this point, whether or not one is concerned about the stress (and resulting sickness and suffering) of the animals for what they are in themselves, one is concerned because the stress is jeopardizing the safety in the food-producing operation.

4. OVERKILL OF DOMESTIC AND WILD ANIMALS

When systems tend to overshoot, their operators are likely in result to be forced to overkill. Once a disease is found unexpectedly in the animals, the danger hits the press, and the regulatory authorities decide to go safe, there is likely to be overkill. Perhaps the overkill is justified by the safety caution, given the unknown dangers. But notice that, after the alarm, government authorities, now embarrassed, are likely to wish to show their muscle, as much to impress citizens, as to control the epidemic. They are now watching the spread of public opinion as much as of the disease [22, vol 1, p. 98, pp. 127-129]. In choosing their strategies, they want to reassure the public and also to re-assure customers at home and abroad.

In any mass slaughter program to prevent the spread of a newly found and feared disease, by far the vastest number of the slaughtered will be quite healthy animals. Most of the slaughter will be on suspicion or "just in case," a thousand cows for every one that has foot and mouth disease. If the cull includes all the animals on nearby farms as well (within three kilometers in Britain), that will result in devastating hardship on innocent owners. Innocent owners may have little choice once the cull policy is in place; the policy is dictated. Or if not dictated, any farmer with misgivings is shunned as being unpatriotic; their cows may be killed willy-nilly [34, 35].

The mass slaughter program kills, probably by less than the most humane

methods, large numbers of perfectly healthy animals. Most of the animals were destined to be killed and eaten, of course. But at least then some good would have come of their deaths. In the cull, the animals are wasted. The U.K. killed 6 million animals in the 2001 outbreak of foot and mouth disease [36, 37]. In the BSE epidemic 170,000 cows died from BSE, and another 4.7 million were killed in a precautionary slaughter, and over 140 persons died from new variant Creutzfeldt-Jacob Disease, contracted as a result of exposure to contaminated meat [22]. One kind of pressure, to have food fast and cheap, pushed too far, results in another extreme, massive slaughter and waste. Fear of Asian flu led to culling of 20 million chickens in eight nations [12]. Public health is at stake, as authorities will correctly claim. But what drives the overkill may as much be economic fears of industry collapse. Certainly minimal killing and concern for animal suffering is not an issue.

Nor is the overkill simply among domestic animals, since the wild vectors of the disease now also fall under suspicion. If waterfowl are sources of new pathogens, one approach would be to exercise much more care in allowing wild and domestic fowl to interact. An equally effective and perhaps cheaper plan would be to kill the wild birds in the area. Often, however, it is not known how a pathogen is being spread, whether in wild populations or in domestic populations. In the case of the H5N1 avian influenza virus, both migrating wild and commercially transported domestic birds are variously implicated. The significance of the transmission routes is still under debate. Sorting out the vectors is difficult for complex reasons. The disease spread poorly fits the migration routes; migrating birds are healthy enough to fly and typically asymptomatic [23]. Culling wild birds would be premature on the basis of present knowledge.

Wild animals are estimated to be the source of more than 70 percent of all emerging human infections [24]. Culling wild animals is more difficult, especially in developing nations. But hunting pressures on such animals may be increased. Often the killing in the wild is by reverse contamination. This spread of contagion is a two-way street. Recent quantitative analysis finds that anthropogenic introduction of pathogens (called "pathogen pollution") may account for 60 percent of the emerging diseases of wildlife [38]. Endangered wildlife populations can be pushed to the brink of extinction by these links generating new stresses as a result of commercial pressures, and, under fear of emerging pathogens, efforts in surveillance and control [39].

5. BLAMING WILD NATURE?

Those who advocate precaution need to use some additional precaution here. A first line of precaution will argue that these pathological organisms do come from wild nature. Ecosystems are full of diseases and we cannot let them spread into our human cultures. So we must eliminate the natural reservoirs. Facing the threat of pandemic diseases, Andrew Dobson, an ecologist at Princeton University, concludes that conservation biology has "almost as important a role as medical schools." He continues, finding that there are two alternatives in thinking of the disease etiology: "either to reduce the prevalence of the pathogen in the reservoir host, or to identify the conditions that lead to spillover and attempt to minimize these" [15, p. 629]. The first tries to fix the problem by focus on the reservoir in wild nature. The second fixes the problem by focus on the upsets that humans have introduced to trigger the pandemic and create a route for its spread.

The second level of precaution is to avoid blaming wild nature for these diseases, having failed to use adequate precaution in our escalating disruptions of

these wild systems. Habitat fragmentation displaces wild animals, and the animals in atypical circumstances may provide new niches for their pathogens, or the displaced animals may carry their pathogens to new hosts, often domesticated animals. Populations of humans or domestic animals exposed to new infectious organisms, especially when crowded or stressed, may develop explosive epidemics, although the pathogen endemic in its original niche is carried by its hosts at low-level and without serious disease outbreak [40]. In natural ecosystems, pathogens and parasites are, for the most part, integrated into the routines of these systems — although even in wild nature there are occasional epidemics. But presumably these viruses and microbes are adapted fits in the niches they occupy in wild nature; the birds and the wildlife have usually learned to live with them [23].

When we humans move such organisms into our global capitalist economies, radically altering their habitats from anything resembling an ecosystem, we might first suppose that they will soon wither and die. Many do. But, surprisingly, we are now finding that we can also invite an unprecedented explosion, a pandemic. Since we create the context in which the pandemic appears, one can as well say that we humans create the disease as that the disease originates in wild nature, HIV/AIDS, before jumping to humans, existed in primate populations in Africa, with which it had co-evolved. It might never have emerged as pandemic if it were not for the social disruptions in post-colonial and sub-Saharan Africa, with the bush-meat trade; the movement of rural populations to large and crowded cities, caught in poverty there; with disrupted family structures promoting promiscuity and prostitution — all of which facilitate HIV transmission [7, p. 243].

I began with analogy between aphids killing fir and hemlocks and human pandemic diseases, I close with another analogy between ecosystems and pandemics. On a field trip examining the aftermath of the massive 1988 Yellowstone fires in the company of fire ecologists, I asked whether this or that fire was caused by lightning or by careless humans. An ecologist replied: It makes no difference whether the source of ignition was a human match or a lightning bolt. The cause of the fire was the overload of fuel building up from decades of fire suppression. Yellowstone was a fire waiting to happen; if a camper does not ignite it this year, a lightning bolt will next year, or the year after that. Put the lodgepole under stressed fuel load, and you will get a fire, later if not sooner.

Similarly with these pandemics. Stress the chickens, stress the bats, stress the pigs, stress the suppliers, stress the markets, stress the crowded and poor, or busy and fast-flying people, and you'll get a pandemic, later if not sooner. The cause is not so much the microbe as the context of "fuel load," so to speak. The mismatch between ecology and social matrix is a pandemic waiting to happen.

The driving forces creating this complex of problems have heavy momentum. One ought to examine the prevailing practices actively and to counteract them consciously. The economic juggernaut is coupled with a political juggernaut to push for development, growth, more and more for less and less. Those who can see the inclusive picture of how this affects global and local health, human and ecosystemic, need to shift the burden of proof on those who wish to introduce more rapid changes and to raise the standards of caution by pushing in reverse. There is no better way to raise the alarm than to cry "one world, one health."

Do we not have an ethical responsibility not to create diseases? Equally not to create the context in which disease is likely to happen? Does not the Hippocratic Oath require, first of all, that we do no harm? In preventing such harm, we do not

always fault nature; more often we may be able to learn from nature how better to fit our economies in with the ecologies and communities of life on Earth.

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