

INTERVIEWER: We are very lucky to have Ann Linder join us today and present her research on the future of live animal markets. Ann is the Wildlife and Live Animal Markets Fellow at Harvard Law School.

ANN LINDER: So thank you so much for having me. I'm Ann Linder. I'm a research fellow with the Harvard Animal Law and Policy Program. And today I'm going to be presenting about our research, our ongoing research I should say, as to issues of animal markets and zoonotic disease.

So first I want to say thank you to the Brooks Institute for Animal Rights Policy for supporting this work and to offer for hosting us here tonight. While this project is primarily housed at Harvard, we're part of a larger constellation of schools working on this issue. So this is really truly an interdisciplinary and collaborative effort.

So to get started, this is the part of the story that we all know. So after news first breaks about COVID-19, suspicion starts swirling around this particular animal market in the city of Wuhan. And while the exact origins of COVID aren't known despite the WHO report that came out earlier this week, we know that 35 of the original 41 patients have some connection to the market.

And almost as soon as this happens, you see a chorus of calls for blanket bans on, the term that has been used is wet markets, without really even a basic understanding of what these markets even are or the larger cultural context. So we undertook this project in part to inform that regulatory discussion.

So from a policy perspective, we found that there are a few significant gaps in the knowledge that we hope to examine and correct through this research. First, we wanted to address the misconception that this is a risk that only exists in a particular country or region. So animal markets exist throughout the globe, including in the United States and Canada.

Second, there's some basic definitional questions that still persist. For example, what is a wet market? What constitutes wildlife? And we feel there needs to be a shared understanding of these key concepts in order to move forward.

Third, the policy discussion that we saw really lacked nuance. There were kind of only binary solutions and many of them weren't practical in any real sense. Next, there was little that was known about prior attempts to legislate in the space, a, worked, what hasn't worked. So we wanted to kind of bring in that historical context.

And lastly, while much of the media focused narrowly on this issue of markets, we recognize that these are really only one step in a larger supply chain. So we hope to add in some of that context and texture through our research.

So why focus on markets? Regardless of COVID, we know that these are important sites that facilitate the spread of zoonotic disease. And to understand why, we have to take a closer look at the ecology of disease. So the WHO estimates that about 3/4 of emerging infectious diseases are zoonoses, meaning that they're of animal origin.

There are a few key questions that epidemiologists will ask in the wake of an outbreak. First, what kind of pathogen are we talking about? So much of our work focuses on viruses. But they're just one form of zoonoses. Animals can also transmit bacterial diseases like the plague, prion diseases like mad cow, as well as fungal and protozoan pathogens. So next for viruses, we want to identify hosts, learn how it spreads, and then assess what is the risk to any given population.

So a little bit of background here. Every species has its own catalog of viruses that it carries within its population at any point in time, including humans. So scientists estimate that about 8% of our DNA we carry is derived from ancient viral DNA. For our purposes, the important point to know is that viruses exist in nature at all times and that each species has their own set of viruses that they carry.

So I carry human viruses. Bats carry bat viruses. Cows carry cow viruses. And from the virus standpoint, each one has one or more what we call natural reservoirs, which basically allow the virus to survive indefinitely in nature, often without causing severe symptoms of disease on its host species. So you can kind of think of this as a form of truce between the virus and its carrier.

So there's two different ways that a virus can get to humans, either through direct transmission, as we see at the top there. We can be infected by the reservoir species itself. Or more commonly, the virus will pass to humans through an intermediate host. So not every virus found in a host species can be passed to humans. It's kind of a lock and key concept.

So these intermediate or bridge hosts take the virus from the reservoir species and package it in a way that it can be transferred to humans. So to give a real life example here, we've got Hendra virus, which caused the death of racing jockeys and veterinarians across the country of Australia. Now bats were identified as the natural reservoir for Hendra, but even Hendra positive bats that wildlife rehabilitators could not give them the disease.

Instead it was horses who were grazing underneath the trees where the bats roosted that became infected with Hendra had a low viral load, amplified the virus within their body and then were able to transfer it to infect humans. And this is something we see time and again. With Nipah virus for example, that came originally from bats as well but came through pigs.

Ebola, again from bats, through what we believe was the bushmeat trade in primates and infected humans that way. So the really important point here is that it's not simply the human animal interactions that determine the risk of zoonotic disease, but the interactions amongst and between the animals themselves. And so that is one reason why these markets are so dangerous.

With all these different species of animals sold together, the virus has kind of a buffet of different options for intermediate hosts that it can choose from and pass through. And those animals can be wild or domestic. You might hear that there's very little risk from domestic species, and that's not the case. They can act as a reservoir host. They can also act as an intermediate or bridge host.

And one last note here about spillover. Spillover, many or most spillover events might go unnoticed. So they often occur in remote areas without ever being reported or cataloged or identified. So viruses can emerge, infect one or two people and then kind of just disappear again into the forest for another 100 years.

Spillover can occur at many discrete points and places and times. So we think that HIV for example, may have spilled over as many as 12 different times before it emerged as a global epidemic and killed 32 million. So now that we have spillover, what happens then?

Once the disease comes to us, there's a few questions that are going to determine its course. So the first, can it be spread from one human to another? So zoonoses may spill over and infect an individual but unless that person can infect another person, the spread will likely in there. So there are zoonoses we can get but not give.

An example here might be highly pathogenic avian influenza, which is very deadly. But because it can't transmit yet, easily from one human to another, the affected persons are usually poultry workers. And despite that though, it's resulted in the culling of millions of birds worldwide.

So next, how contagious is the virus? And this is measured by the variable R-naught. So that indicates basically, given one case of the virus how many new cases will that case create. So if the R-naught is equal to one, the number of cases will stay the same. But any greater than one and it's going to continue to spread throughout a population.

The R-naught for COVID is difficult to estimate. But folks have put it around 2.4, which is significant but not compared to some of the other diseases we might have heard of. The chicken pox R-naught for example, is about 10 to 12. Measles, you're looking at somewhere between 16 and 18. So it's important note also that the R-naught changes over time as we take preventative measures, as we get our vaccinations, it's going to change based on cultural response.

And then lastly here, there's some relationship between transmissibility of a virus and its virulence. In other words, how many people you can give the virus to is in part a function of how deadly the virus is. And speaking very generally here, things that kill you fast can't get very far. If you think about rabies for example once you're contagious, you're practically dead. Ebola, similar story to a lesser extent.

So in terms of assessing the devastation or impact of a virus, there's going to be some area under the curve, where mortality is maximized and the death count will be at highest. So flat bans of animal markets are usually not politically or practically feasible. And so there's a few different ways that we started to look at the problem.

Here we're looking at high risk species and high risk interactions and then high risk areas that present the greatest threat of zoonotic disease. So if you can picture these as sort of a Venn diagram of overlapping spheres, markets are one place where these risk factors are consistently coming together. In terms of high risk species, in general, the research tends to suggest that the species groups that present the highest risk for zoonoses are bats, primates, and rodents, and to a lesser extent animals like small carnivores.

There's a few different reasons for this. Bats for example, they're highly common. There are over 1,200 different species of bat. So when we say bat, it's a whole collection of species. They're also very social. So they nest together in really high stocking densities you could have up to 500 bats roosting on the one square foot. So you can imagine how quickly diseases can spread amongst these communities.

Primates, it's a bit of a different story. They're very genetically similar to us. So it's not difficult to imagine that we can get many of the same diseases that they can.

And so kind of going back, one of the questions we're hoping to answer is, if you can't fix the whole problem, where do you start? So a good first step would be regulating these high-risk species and high risk interactions, such as those that exist in markets, where you have a lot of stressed animals in poor condition that are stored together, exchanging fluids and sometimes being slaughtered on site. So again, markets are one place where we see these risk factors collide.

However, markets are also only one node in this larger supply chain that we talked about. So this is a study that was published earlier this year, looking at coronaviruses with samples taken back in 2014. So this is not COVID-19, but other types of coronaviruses. And what they did was basically measure the rate of these viruses in populations of field rats, which are commonly consumed in Vietnam at different points in the supply chain.

So they estimate that about 10% of them tested positive when they were first captured by hunters. By the time they were sold by trappers that number jumped up to 20%. And then when we see them so that these larger markets, 32% of them tested positive for one or another form of these coronaviruses. And then finally, by the time the rats reach the plates of restaurant goers, 55% of them, over have tested positive for one of these types of viruses.

So this is troubling for a few reasons. But one is, it suggests sort of maximal risk to endpoint consumers. Whereas something like subsistence bushmeat, you're eating much closer to the source. There might be a lower risk there. But you can really see kind of how the animal-animal interactions are dictating the risk of disease in this particular case.

Now notably the study also sampled field rats from a wildlife farm where they were grown commercially and raised. And they found that 100% of the field rats that were commercially farmed tested positive for one or another form of this virus. So as such, we are also really interested in ideas of sourcing. So one industry of particular relevance to us is wildlife farming.

So this is sometimes pitched as a sustainable alternative to hunting. In many parts of the world though, this is a huge industry, whether it's tiger farming in India or bear bile farming in Vietnam. And this is, I think, we can see in context, part of a larger movement towards the privatization of wildlife.

So many governments encourage citizens to use wildlife as a means to support themselves and generate income. So in China alone, the wildlife farming industry is worth \$74 billion a year and employs 14 million people just in China. So if we took those workers, and we made them a state in the United States, they would have about 25 electoral votes and would rank fifth just behind New York in terms of population size.

So this is happening on a huge scale globally, even though it sounds very foreign to us here today. So the majority of those workers are working in fur production, and just after that would be wildlife raised for food, and then finally wildlife phrase for medicinal and other uses. So in the wake of COVID, there's been an about face in terms of the government's policy towards wildlife farming.

The Chinese government has started buying out farmers, requiring them to cull their stock. But we've also seen, amongst our case studies countries move in the opposite direction. So South Africa, for example, is now trying to allow for commercial meat production from animals, like giraffes, which weren't previously allowed to be raised as livestock.

So there's also implications for domestic animal agriculture. Here in the United States, about 99% or more of the animals that we eat were raised in CAFOs, or what we call industrialized factory farms. So as you can see, these animals are not exactly socially distanced. And in fact, the conditions that oftentimes exist in the facility are precisely those that allow for the spread of disease.

So you've got a lot of animals that are crowded together. There's poor ventilation, poor hygiene, and oftentimes extreme stress. On top of that, you've got low genetic diversity, which tends to act as a natural buffer to disease.

So one last point here is that to prevent these animals from getting sick under these conditions, many are fed a steady stream of preventative antibiotics. About 70% of the antibiotics produced globally are fed to farm animals to keep them healthy. So that exacerbates the overuse of antibiotics, and in turn kind of drives the creation of these antibiotic resistant strains of bacteria.

So not only is animal agriculture increasing our risk of zoonotic disease, it's also making us less equipped to combat those same types of infections and outbreaks. Finally, when we talk about high risk regions, we want to think about areas of high biodiversity where the landscape is undergoing significant change. And this change is generally caused by human drivers, such as deforestation, population expansion, climate change, that sort of thing.

There's evidence to suggest that the rate of infectious disease outbreaks is increasing with time. And so we believe that these sorts of episodes will only become more common. And that concept in the literature is something known as the Stockholm Paradigm.

So what are we doing about all of this? They are complex problems that require thoughtful solutions. So we're tackling this issue through a case study approach where we've got teams working on the ground to look at markets on a more granular level.

And the setup, we hope will provide us a better understanding of the diversity of types and cultural considerations surrounding markets, but will also elevate these local voices and allow them a platform to provide culturally sensitive community-based approaches. This is not a one size fits all problem. And so what we'd like to do at the end of the day is kind of provide a menu of regulatory options in order to meet people where they are, providing solutions that are both politically and practically feasible with the understanding that what works here in America, is not going to be the same thing that works in Angola.

So at the end of the day, what we hope to do is give legislators a toolbox to meet the challenges of this moment and meaningfully address these issues in a culturally sensitive way. In terms of what types of markets we're looking at, it really runs the spectrum. So we're looking at markets for kangaroo meat in Australia. We're looking at canned hunting and cub petting markets for lions in South Africa.

We've got exotic pet trade coming out of Indonesia, roadside bushmeat markets in Peru. So both domestic animals and wildlife are very much at the forefront of our research here. And then in terms of the United States, I think one thing that's really important to note is that many of these same practices exist here in the United States, even though they might operate under a slightly different name.

For example, when we say bushmeat, that sounds really foreign to us. But we have bushmeat here as well. We just call it game. And then we have canned hunting here as well. We just call it game ranching.

So many of these exist everywhere and various different forms. We are the world's largest importer of illegal wildlife here in the US. But we also export wildlife. So the US last year alone sent 10 million turtles overseas, most of them to Asia to be used for human consumption.

And we also import and export domestic animals as well, to the tune of about 126 million every year. We also have wildlife farming here. We just call it fur farming. So the only case of COVID-19 found in a free roaming wildlife was a mink that was trapped outside a farm in Utah. And that mink was infected by minks living in the facility who obtained the infection from humans.

So this is dangerous because it risks creating new natural reservoirs for these diseases and increases the chances for a virus like COVID to mutate, which it did on European fur farms, such that Denmark ordered the culling of 17 million mink, though the US chose not to do the same here.

And lastly, we're also looking at the online trade. We want to be sort of prospective in seeing where these trends are headed in the future. And what we're seeing oftentimes is that many, if not most, of these transactions now are a hybrid between physical and virtual marketplaces. So we're especially interested in these kinds of cyber enabled transactions.

Lastly, what does all of this mean for us? And I think to me, it means that the choices we make matter. Each of us in some way has participated in some of the markets that we're looking at here. And I think really it's very important to understand that these production systems are more connected than we might think.

For example, we know the rainforest is being cut down, but what is it being cut down for? Maybe it's to grow soybeans that will ship to another part of the world that will be fed to pigs in Spain. And then these live pigs are then exported to Italy for slaughter so that their meat can be culled, not just ham, but Parma ham and then ends up in our grocery stores back here in the United States.

I wanted to read quickly a quote from Pat Brown, who's the founder of Impossible Foods. Using animals for food makes up the vast majority of the land footprint of humanity. All the buildings, roads, and paved surfaces in the world occupy less than 1% of the Earth's surface, while more than 45% of the land surface of the Earth is used as land for grazing or growing crops to feed livestock.

So there's a huge impact that each of us are having every day with the decisions that we make. Generally speaking, intact healthy ecosystems produce fewer disease outbreaks than degraded ones. So as we venture farther into the forest and bring with us our non-native species and domestic livestock, as we ship exotic animals all over the world to be our pets, and as we continue kind of change our environment to suit our whims in big ways and small through this unnatural mixing, we're also creating opportunities for diseases that never could have arisen in nature.

So until we meaningfully address these underlying issues, we're going to continue to put ourselves and our planet at risk until we are able to undergo this kind of a fundamental shift in the way we relate to nature. So thanks so much for listening, and thank you to our hosts. I'm really grateful and happy to be here.