Weaponizing Diversity Against Extinction

How Being Unique Ensures Your Survival

Amanda Roberts | January 25, 2020

Courtesy Photo by The National Museum of African American History and Culture - Frimages

If you needed another reason to "embrace what makes you different", look no further. From your height, to your eyes, to your skin and all the way down to your genome, the traits that set us apart from each other not only make this world complex and beautiful but supports our survival as a species! As you may know, all humans are 99.9% genetically identical. Even though we have near identical genes, that 0.1% difference in our genomes accounts for a range of traits and characteristics expressed in the diverse human population today (NIH). Not only is this heterogeneity socially beneficial, but genetic variation is also a biological advantage since diversity acts as a protective barrier against invasive organisms. For example, we all have different blood types that we inherit from our parents. But did you know depending on your blood type you may have natural immunity to certain pathogens and parasites? One such blood specific invader, is the norovirus that causes vomiting and diarrhea in humans. This virus is contagious among humans, but studies have found that the norovirus can bind to type A and O cells but cannot bind to the blood cells of type B (Ewald et al, 2016). This means that having diversity in our blood types protects certain people from organisms that may cause them harm! We call this a host-parasite—or host-pathogen relationship. One organism lives by using another organism as it's source of food, shelter, or personal breeding ground (yuck!). Host specific parasites, or parasites that need to find their 'perfect match', depend on their host for survival. If these parasites are unable to find Mr. Right, then it can't attach to a host, and won't survive.

So how does diversity protect the human population from these parasites? Think of it like the famous matching game we all played as kids, Concentration. Here you have 52 cards all face down, and you try to pair the cards with their perfect match. Every time you flip over a card and search for its other half, you're acting like the parasite in the host-parasite system. At the beginning of the game, it is more difficult to find a set since there are a variety of different cards available to match. As the game continues and the number of cards dwindle down to only the leftover pairs, there isn't as much of a variety as before, so you are almost guaranteed to find your match. Host-parasite interactions work in a similar fashion. The more diversity in a population, the harder it is to find a suitable host to attach to. However, in populations with less variety...certain death is almost a guarantee.

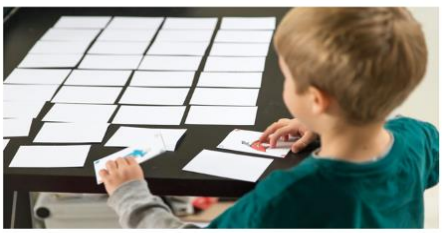

Figure 1: Memory Match Game
https://www.hairwhisperers.com/post/keeping-it-clean-4-games-for-teaching-kids-healthy-sharing-habits

This defense against parasitic invaders is a growing field of study in the scientific community. Although the idea that diversity is a great biological advantage for many organisms is widely accepted, new studies reveal that this host-parasite relationship is more complex than previously believed. Research biologists Amanda Gibson and Anna E. Nguyen aim to challenge the idea that diversity protects all plant and animal populations from parasites by reanalyzing the effects of genetic diversity in different contexts: variation based on the type of study and variation based on the type of host.

The kind of research that takes place in a lab rather than in nature is called an *experimental study.* On the other hand, research with no change from natural conditions or scientific intervention is called an *observational study*. Despite its lack of 'real world' conditions, experimental studies allow scientists want to account for every variable involved in the experiment. However, this allows for some differences to arise in the results of experimental and observational studies. In their research, Gibson and Nguyen found that experiments in labs show that diversity especially slows down parasitism in plants but there was "no consistent relationship between diversity and parasitism in natural populations" (Gibson et al, 2020). But why would experimental and observational data be so contradictory, and which one should we trust? Well…it's complicated. Experimental studies allow us to manipulate a single factor to determine the causal relationship between two variables. Observational studies do not allow for this type of specificity through manipulation, but they allow us greater insight into the functions of many variables in a natural environment, so both studies have something to offer. Upon closer examination, the difference in the results confirms the benefits of genetic variation. If there is little to no correlation between diversity and parasites in a natural environment, then we can connect a population's ability to respond to parasitic selection to the type of host it is (Civitello 2015).

The effects of parasites differ based on if the host is a plant or animal, but in both these populations, freeloading parasites still play a role as a *selective force*—an environmental or social pressure that affects an organism's ability to survive and reproduce. Scientists readily accept the benefits of diversity in crops because plants experience the *monoculture effect*: a term coined for a parasite's ability to "transmit more successfully among genetically similar" crop hosts (King 2012). Additionally, Gibson and Nguyen found that cross-bred rice plants didn't even need a fungicide to prevent parasitism! However, this outcome didn't apply to *every* plant species as some wheat combinations only showed a 28% reduction in disease. Gibson and Nguyen highlight similar effects of genetic diversity in animal systems as well. In a study of 23 animal populations, there was decent reduction in parasitism in connection to genetic diversity. Although the biologists don't mention specific hosts, Gibson asserts that "this effect varied with study setting and parasite type" (Gibson et al, 2020). From their findings, we can conclude that overall parasites thrive in populations where they match with all hosts available, so populations lacking in genetic diversity are heavily affected by the introduction of a matching parasite.

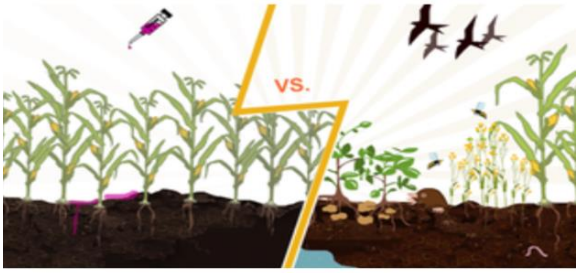

Figure 2: Monoculture vs Biodiversity
https://palmaozedongoil.weebly.com/monoculture-plantion-impacts.html

But what do studies on plants and animals have to do with us? Well, it could actually reveal a ton of significant insights! Although the study mostly validates the longstanding beliefs on the advantages of diversity, the slightly different correlations in observational vs. experimental and noncrop hosts vs. crop hosts tell us that we have a ways to go before we fully understand how we can make diversity work in our favor.

With time humans will be able to take a more proactive approach to treating disease as scientists study that 0.1% of genetic information that sets you apart from the people around you. Scientists urge us to pay greater attention to this concept as a "decline in genetic diversity does increase the risk of extinction" (Osada, 2015). Although we might believe that we'd be able to use our intelligence to avoid these risks, an attack on diversity in plants and animals will directly affect our way of life. Biodiversity losses could increase diseases in our food sources, and we'd experience epidemics the likes of which we haven't seen since the deadly Potato Famine! Moving forward, understanding the importance of diversity will help us determine the best approach to disease for our plants, our animals and ourselves.

More Key Terms

Biodiversity: the wide variety of species on Earth	**Heterogeneity:** consisting of different qualities
Genetic diversity: all the different genes or traits present in individuals or a population	**Environmental Pressure:** reason for change in a population (ex. climate change, predation, or mating preference
Fungicide: chemicals farmers use to kill harmful fungus on plants	**Cross-bred:** to combine different types of breeds or varieties to make mixed-trait offspring

References

Benjamin, Claire. 2014.Classic Lewis Carroll Character Inspires New Ecological Model. *Illinois IGB*, Carl R. Woese Institute for Genomic Biology. www.igb.illinois.edu/article/classic-lewis-carroll-character-inspires-new-ecological-model.

Civitello, D. J., J. Cohen, H. Fatima, N. T. Halstead, J. Liriano, T. A. McMahon, et al. 2015 Biodiversity inhibits parasites: broad evidence for the dilution effect. Proc. Natl. Acad. Sci. 112:8667–8671. https://www.jstor.org/stable/26466019?socuuid=7600e3c0-2c65-41b8-a8f2-911e0d26b7a1&socplat=email

Ewald, D. R., & Sumner, S. C. 2016. Blood type biochemistry and human disease. Wiley interdisciplinary reviews. Systems biology and medicine, 8(6), 517–535. https://doi.org/10.1002/wsbm.1355

National Institute of Health (NIH). 2018. Genetics vs. Genomics Fact Sheet. Retrieved January 17, 2021, from http://www.genome.gov/about-genomics/fact-sheets/Genetics-vs-genomics#:~:text=All%20human%20beings%20are%2099.9,about%20the%20causes%20of%20diseases.

Gibson, A.K. and Nguyen, A.E. 2020. Does genetic diversity protect host populations from parasites? A meta-analysis across natural and agricultural systems. Evolution Letters. https://doi.org/10.1002/evl3.206

King KC, Lively CM. 2012. Does genetic diversity limit disease spread in natural host populations? Data from Heredity (Edinb). 109(4):199-203. https://pubmed.ncbi.nlm.nih.gov/22713998/

Osada N. 2015. Genetic diversity in humans and non-human primates and its evolutionary consequences. *Genes & genetic systems*, *90*(3), 133–145. https://doi.org/10.1266/ggs.90.133