Claim to Flame Notes
Go Forth and Science Podcast
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6/13/2020

Pausas, J.G., Keeley, J.E. 2009. A burning story: the role of fire in the history of life. Bioscience; 59 (7): 593-601

- Fire only existed on our planet once we had plants: for fuel and oxygen in the air
    - There was enough oxygen 540 million years ago, but plants and evidence of fire only 440 million years ago
- There were less fires when there was less oxygen in the atmosphere, and more fires when there was more O2 in the atmosphere
- Fires were similar hundreds of millions of year ago to the ones we have today: the underbrush in a pine forest burns every few years, clearing that out but not killing the trees. Or in wetlands, the crowns of the trees would burn
- To have a forest fire, there must be a dry season that allows things to become fuel
- Different types of fire and the ecosystems they occur in go hand in hand with a lot of tree evolution: do the crowns burn? Then the tree can resprout. Does just the underbrush burn? Then the tree doesn't resprout. Also there are trees that need fire in order for their seeds to start growing: it means there are a lot of resources available for those new baby trees
- Fire also helped humans evolve: it meant we could have smaller teeth since we can cook and soften our food, and also changed our social behaviors, like gathering around a campfire
- Fire also allowed us to live in colder places
- Evidence of controlled fire use by *Homo erectus* 1.5 million years ago (controversial)
- Evidence of making fire where and when they wanted it 0.79 million years ago (non-controversial)
- As humans wrangled the use of fire as a tool, it also meant we shaped ecosystems with it: clearing ground for living spaces, and "regenerating plant food sources" aka agriculture
- When there is a societal change, like natives to colonizers, or the industrial revolution, there is also a fire regime change
- In Europe, during the industrial revolution, when people stopped farming grazing animals as much, fires became more frequent
- In the U.S., there was effective fire suppression policy for pretty much all of the 20th century, which means we now have a ton of fuel to burn when a fire does happen
- Now that people are also moving in high densities to climates where this fuel buildup has occurred, like California, it means fires are more dangerous and more likely (ignition can come from humans, not just nature)
- Deforestation and fire is also a big problem currently: planned loss of a lot of forest in tropical areas
    - These fires release A LOT of carbon into the atmosphere: fires in Indonesia in 1997 released 13-40% of global fossil fuel emissions that year (burning trees + burning peat)

Scott, A.C., Glasspool, I.J. 2006. The diversification of Paleozoic fire systems and fluctuation in atmospheric oxygen concentration. PNAS; 103(29): 10861-10865

- We can figure out when fires occur throughout geologic history because of charcoal found in rocks (fossils)
- When O2 is less than 13%, a wildfire can't burn no matter how dry an area is
- 13-16% O2 can have a fire, but only with really dry plants
- 18-23% O2 is like the fires we have today (current level is 21%), where dry seasons help increase the number of fires
- Greater than 25% O2 means a lot of fires, especially in stormier areas with lightning
- Greater than 30% means fire everywhere
- Greater than 35% and fire can't be extinguished, so it would burn everything and then there wouldn't be any fuel left to sustain the fire
- Most of the charcoal in the fossil record is from wildfires

Fidelis, A. 2020. Is fire always the "bad guy"? Flora; 268: 1-3

- 2017 US fire season: spent 18 billion to combat the megafires and "the total burnt area was the third largest in the history of the country"
- Fire media attention is increasing, and because of the socioeconomic impacts of fire, it's always portrayed as bad. "A picture of a firefighter next to a koala during a wildfire in Australia got my attention and probably brought people the feeling that fire is synonym of tragedy"
- Fire around since the end of the Silurian: 420 million years ago
    - What started a fire back then?: volcanic eruptions and lightening
- We have so many different flowering plants today because of fire in the past
- Early humans used fire for: heat in colder areas, cooking, rituals, cleaning, hunting
- Humans decided to live in flammable ecosystems, so our houses are burning
- Big fires happen at the end of the dry season because there is more dry fuel to burn
    - And the rainy season is starting, which means more lightning strikes
- Suppression changes ecosystems and leads to larger fires when they do occur
    - More dead fuel
    - Can ignite in the middle of the dry season (meaning the fire will last longer)
    - Invasive species that are more flammable
- We need fire to maintain open ecosystems like grasslands and savannas, otherwise they'll turn into forest, which means losing grassland species and ecosystem services
- "Fire is not always "good" or "bad". It will depend on where, when and how it occurs."
    - Fire is good in fire-prone ecosystems, like tropical grasslands, and help to maintain ecosystem diversity
    - In fire-sensitive ecosystems, it can be bad
- Wildfires in the Amazon in 2019 were because of deforestation rather than drought
- Political decisions are made for the impact on humans, not on the ecosystem

Rogers, B.M., Balch, J.K., Goetz, S.J., Lehmann, C.E.R., Turetsky, M. 2020. Focus on changing fire regimes: interactions with climate, ecosystems and society. Environmental Research Letters; 15: 1-11

- Fires are necessary, but also pose a threat because of our expansion into wildlands, and because of climate change

- 3% of Earth's surface burns annually
    - Half of Africa has a 10% annual burn fraction, same with Australia. Otherwise high burn spots are on the edges of the Amazon, and in central and southern Asia. Most of the rest of the world is at 0-2% mean annual burn fraction
- Fire forecasting, like weather forecasting, is becoming a thing, especially in the Amazon
- Western U.S.: "The combination of climate change, history of aggressive suppression in systems adapted to frequent low-severity fires, and expansion of the wildland urban interface have created conditions for increasingly dangerous fires."
- 2/3 of the fire in the western U.S. are because of lightning strikes
- After a fire, there is more water in streams because of "reduced transpiration and soil infiltration"
- Australia is a hard place to define fire regimes and find patterns in the fires, because the climate changes a lot from year to year
- In northern boreal forests, fires only are 2% of annual burned area, but they are 9% of global fire carbon emissions because they are severe fires and deep organic soils
    - Polar amplification is also leading to greater temperature increases in the north and south, which also means stronger fires
    - Most fires happen in mature black spruce stands, but other types of forests are starting to burn now too, like deciduous forests
- In the Amazon, fires are linked to deforestation and are started by humans for agriculture or land clearning
- Increased burning in the tropics because of humans and decreased burning in the temperate zone because of humans
- In southern Europe, changes in land use and suppression has more of an effect on fire regimes than climate change does
- Indonesian palm oil plantations occur on cleared peatlands, and fire is used to clear and maintain them. In recent years, a specific certification program designated that fire should now be used as a last resort when it is the least damaging option. But so far it's only been shown to work in wet years and on non-peatland plantations
- Decreases in fire in the 19th and 20th century are because of human fire suppression
    - Based on climate data, the largest fires in eastern Canada happened between 3000 and 1000 years ago
- For the future: in forests, "fire frequency and severity will increase," and in fuel-limited systems, fires will decrease as things dry out and fuel becomes rarer
- In the last few years, there have been extreme fire events in Alaska, Canada, Siberia, the western U.S., Europe, Indonesia, Australia and the Amazon.

S Archibald, et al. 2018. Biological and geophysical feedbacks with fire in the Earth system. Environmental Research Letters; 13: 1-18

- "Roughly 3% of the Earth's land surface burns annually, representing a critical exchange of energy and matter between the land and atmosphere via combustion. Fires range from slow smouldering peat fires, to low-intensity surface fires, to intense crown fires, depending on vegetation structure, fuel moisture, prevailing climate, and weather conditions."

- These different kinds of fires occur in difference places around the world and at different frequencies. An intense fire with a lot of fuel won't burn as often as a smaller fire with less fuel.
- "Pyromes": the biomes of these different types of fire