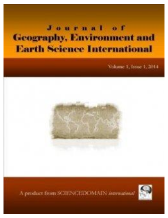

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Previously Unrecognized Primary Factors in the Demise of Endangered Torrey Pines: A Microcosm of Global Forest Die-offs

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Authors' contributions

This work was a joint effort between the authors that is part of an ongoing collaboration aimed at providing scientific, medical, public health and environmental implications and evidence related to aerosolized coal fly ash including its use in the near-daily, near-global covert geoengineering activity. All authors participated in the investigation, analysis and writing the manuscript. Author DDW conducted field investigations in California. Author MW conducted field investigations in Florida. All authors read and approved the final manuscript.

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ABSTRACT

Objective: Forests worldwide are experiencing die-offs on an unprecedented scale. So too is the endangered Torrey Pine, *Pinus torreyana*. Just as the global toxicity from acid rain was recognized and abatement measures taken, a new undisclosed source of atmospheric toxins from geoengineering rapidly escalated to near-global scale. Published forensic evidence is consistent with coal fly ash (CFA), the toxic waste-product of coal-burning, being the main particulate used for geoengineering. The objective of this paper is to disclose unrecognized primary factors arising from geoengineering which underlie the demise of Torrey Pines and global forest die-offs.

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Methods: Snow and fog water samples collected after aerial spraying were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) and interpreted in light of extensive field observations.

Results: Atmospheric moisture extracts many elements in water-soluble form from aerosolized CFA, including aluminum, which is hazardous to many biota, especially trees. Needles and leaves trap toxin-laden atmospheric moisture, and concentrate it by evaporation. Additionally, toxin-concentrate evaporates on needles and leaves, adversely affecting respiration. Eventually, the re-solubilized toxin-concentrate falls to the ground and enters the root system. This is one of the primary factors which underlie the demise of Torrey Pines and forest die-offs worldwide. Another primary factor is enhanced solar ultraviolet radiation, which is caused, we posit, in part by disruption of atmospheric ozone by aerosolized CFA, which contains ozone-killing chlorine in variable amounts ranging as high as 25,000 µg/g. Together, these primary debilitating factors weaken trees' natural defenses and make them vulnerable to insects, such as bark beetles, fungal infections, and other biotic factors.

Conclusion: We disclose a natural mechanism whereby trees' needles and leaves concentrate toxins extracted by moisture from aerosolized coal fly ash used for intentional, man-made weather and climate change. This form of deliberate air pollution must be halted to preserve Earth's forests.

Keywords: Atmospheric aerosols; forest die-off; Torrey Pine; coal fly ash; climate adjustment; geoengineering; weather modification.

1. INTRODUCTION

Forests throughout the world are experiencing die-offs of unprecedented magnitude for modern times. The force driving the die-offs is usually attributed to the combination of heat and drought [1,2], usually assumed to arise from climate change [3-5] of the type reported by the IPCC [6]. While affording a simple and potentially popular explanation, the combination of global heat and drought is paradoxical: Vapor pressure always increases with increasing temperature, so global warming should lead to globally increased rainfall [7]. Based upon evidence in the scientific literature and the data presented here, we propose different and potentially correctable underlying reasons for forest die-offs, which are applicable in a broader sense to the well-documented, multiple global fauna die-offs as well.

Rather than dealing in abstractions or generalizations, we consider specifics in the case of the Torrey Pine, *Pinus torreyana*, the rarest and most endangered pine tree in the U. S. [8]. Torrey Pines are broad, open crowned trees, with long gray-green needles that usually grow in groups of five, and reach about 18m (approximately 55 feet) tall in the wild, but grow taller in landscaped areas. They are thought to be the remnants of an ancient forest that grew along the southern California coast, but now grow naturally only on a small strip of San Diego coastline, and on Santa Rosa Island, 282 km (approximately 176 miles) to the north; see map that is Fig. 1. Growing in a Mediterranean climate with hot, dry summers and mild winters, they rely upon an extensive root system and coastal fog to obtain enough moisture to survive. Approximately 3,000 Torrey Pine trees grow naturally today [9,10].

Fig. 1. Map showing the distribution of Torrey Pines

The “centerpiece” of the die-off is Torrey Pines State Natural Reserve, where approximately 30% of the trees died during the years 2015-18, and most of the remaining trees are stressed and injured (Fig. 2). The die off extends to Torrey Pines Extension, a natural area, and to the Del Mar Bluffs open space at the end of Carmel Valley Road, in about the same percentage rates. It also includes irrigated trees on the world-famous Torrey Pines Golf Course (Fig. 3), which is host to the Professional Golfers Association (PGA), and in the Del Mar Heights neighborhood.

The distribution of tree mortality is higher nearer to the coast and could be the result of more fog there (Fig. 2). Although the majority of trees that died are on west facing slopes, many have also died on east or north facing slopes or flat areas. Torrey Pine trees located east of the I-5 freeway, which receive less fog, appear to be in better condition. Trees on Santa Rosa Island are also in better condition. Those trees are of a different variety, *Pinus torreyana* var. *insularis* [10], and are separated from the mainland location by 274 km (170 miles) of open water.

Fig. 2. Principal areas of total Torrey Pines die-off with fog sample collection locations indicated

Fig. 3. Dead Torrey Pines on the Torrey Pines Golf Course suggesting that drought is not the main driving force behind their demise. Inset shows sprinkler watering irrigation

Fig. 4 is a photograph of dead *P. torreyana*, silhouetted against a 'geoengineered' sky that, we submit, is a previously unrecognized major driving force and contributing factor responsible, not only for their demise, but, we submit, for forest die-offs across the globe.

Deliberately seeding the troposphere and lower stratosphere with particulate matter is an activity begun decades ago by the U. S. military for weather warfare research, and progressively increased in intensity, duration, and geographical scope, for which there is ample evidence and intent [11-22]. Sometime around 2010, the aerial particulate spraying became a near-daily, near-global activity, with massive funding, presumably by some sort of undisclosed international agreement, perhaps under the guise of blocking sunlight, "sunshades for Earth", to counteract warming by greenhouse gases. If so, it is a big misconception [6], as the aerial particulate spraying has the net effect of warming, not cooling, our planet.

Fig. 4. Dead Torrey Pines silhouetted against a sky displaying jet-emplaced particulate trails. Photographed March 16, 2018, looking toward High Point Overlook in Torrey Pines State Natural Reserve

Earth receives solar radiation of various wavelengths and re-radiates that energy back into space to maintain the terrestrial thermal balance. Particulate matter sprayed into the regions where clouds form, reflects some incoming radiation, but also absorbs a portion, which is transferred by molecular collisions to the atmosphere as heat. Moreover, the atmospheric particulate matter impedes heat loss from the surface of the Earth and, upon settling on ice or snow, changes the albedo. Rather than cooling Earth, the aerosolized particulate matter causes global warming, a paradoxical circumstance which requires investigation.

For its weather and climate adjustment activities, the U. S. military engages and/or permits the spraying of undisclosed particulate matter into the air we breathe without informed consent, but with other representations, for example, U. S. Air Force document AFD-051013-001 [23]. An example of that particulate spraying is shown in Fig. 4. Sprayed into the atmosphere where clouds form, the particulate matter heats the atmosphere, thus increasing pressure, which can act to oppose natural weather fronts. Also, the particulate matter impedes rainfall by interfering with moisture-droplet coalescence, until the moisture-burden becomes too great, and results in storms and deluges. Moreover, the specific particulate matter used makes atmospheric moisture more electrically conducting, which is beneficial for the use of electromagnetic radiation.

Forensic scientific investigations have demonstrated that the particulate matter dispersed into the lower atmosphere is consistent with coal fly ash (CFA) [24-28], the extremely fine-grained, light-ash waste product from industrial coal-burning that by regulations must be trapped and sequestered in Western nations due to its toxicity. Here we provide additional evidence supporting that identification, and address its toxicological effects, especially aluminum poisoning, with specific emphasis on Torrey Pines. We describe a mechanism and provide evidence of a natural process by which trees concentrate aerosolized particulate pollution toxins, including and especially the aerosolized toxic CFA used for weather and climate adjustment. Further, we present observational evidence indicative of enhanced ultraviolet radiation damage that is consistent with CFA destruction of atmospheric ozone.

2. METHODS

The 2018 snow samples were collected in a new polyethylene/polypropylene container after aerial particulate spraying according to protocol [28]. An aliquot of approximately 250 ml was sent to a Certified Laboratory for analysis by induction coupled plasma mass spectrometry (ICP-MS). The laboratory followed either EPA 200.7 or EPA 200.8 protocols, depending upon the element being analyzed. The measurements were made after filtering the solution to trap particles >0.45 µm. The Torrey Pine fog water sample was collected during heavy fog on a plastic tray beneath shaken tree branches; a 250 ml aliquot was sent to the same Certified Laboratory for ICP-MS analysis by the same procedure.

The background and scientific data on Torrey Pines were reviewed by literature search. The current status of Torrey Pines was investigated by field studies, personal observation, photography, and sampling, etc. Individual trees were carefully examined for environmental and pathogen damage. This information was compared to previous extensive survey data of TP's by one of the authors (DDW) and to surveys of damaged trees in South Florida by another of the authors (MW). The analytical data were interpreted in the context of these observations.

3. RESULTS AND DISCUSSION

Observations and data discussed below suggest to us that aluminum poisoning and ultraviolet damage are the prime drivers of the demise of Torrey Pines, specifically, and of forests worldwide, generally. These weaken the trees' natural defenses and make them vulnerable to attack by insect and fungal pathogens [29-31].

3.1 Aluminum Poisoning of Trees by Coal Fly Ash Geoengineering

Forests worldwide have been under assault through anthropogenic activities, first through ignorance, later through benign neglect. The Industrial Age brought forth the first assault on forests, as unconstrained emissions of sulfur dioxide (SO_2) and nitrous oxides (NO_x) combined with atmospheric moisture to form sulfuric (H_2SO_4) and nitric acid (HNO_3) which precipitate as acid rain. In addition to lowering the pH of rain and concomitantly altering the pH of soil, acid rain releases aluminum in a chemically mobile form from some geological materials.

In nature, aluminum is usually locked up as inorganic oxides. Consequently, biota did not adapt evolutionary defenses to chemically mobile aluminum. As noted by Sparling and Lowe [32]: "*Forest die-offs and reduced survivorship or impaired reproduction of aquatic invertebrates, fish, and amphibians have been directly connected to Al [aluminum] toxicity. Indirect effects on birds and mammals also have been identified.*" Emphasis added.

In the 1970s, scientists began to address the problems of acid rain [33], and regulatory agencies, such as the U. S. Environmental Protection Agency, began to require flue-gas scrubbers to lessen acid rain [34]. But just as these measures were initiated, another source of chemically mobile aluminum began to be introduced into the environment, unknown, and in ever increasing quantity, by jet-spraying coal fly ash (CFA) into the region of the atmosphere where clouds form, as shown in Fig. 4.

Coal fly ash forms by condensing and accumulating in the hot gases above coal-burners, typically as spheres [35]. This is an alien environment with no counterpart in nature, except in coal-deposit fires. Many of the elements present in CFA, including aluminum, are readily leached into chemically mobile forms by exposure to moisture [36].

The main elements in CFA are oxides of silicon, aluminum, iron, and calcium, with lesser amounts of magnesium, sulfur, sodium, and potassium. Primary components of CFA are aluminum silicates and an iron-bearing (magnetic) fraction that includes magnetite (Fe_3O_4). Trace elements in CFA include: arsenic, barium, beryllium, cadmium, chromium, lead, manganese, mercury, nickel, phosphorus, selenium, thallium, titanium, and zinc [37].

Fig. 5 presents analytical results for eleven dissolved elements in rainwater and snow samples for comparison to similar elements leached from CFA in the laboratory [36,38]. By expressing these results as ratios relative to barium we provide a common basis for comparison, thus obviating the variable dilution inherent in each sample.

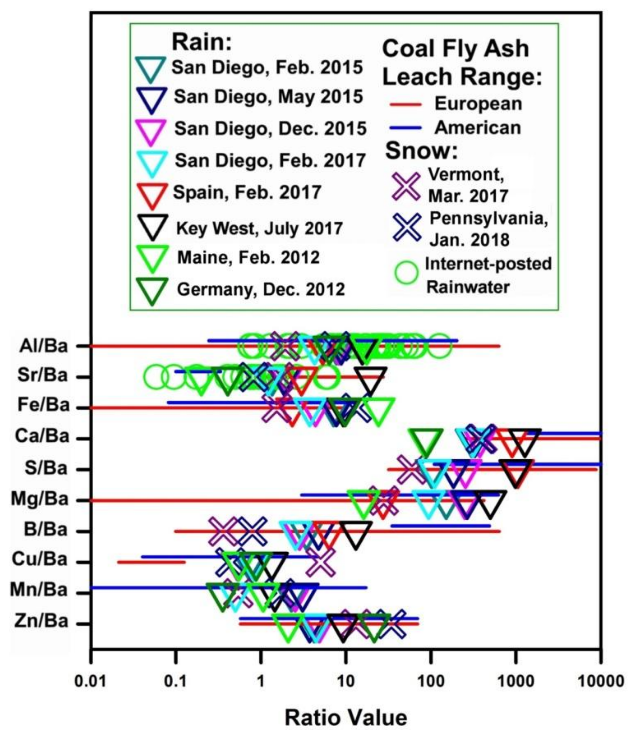

Fig. 5. Element-ratios determined in rainwater and snow samples, collected after aerial-spraying. The 2018 snow data are new; other results have been previously reported [26,27]. Red lines and blue lines, respectively, are ranges of European [36], and American [38] CFA leach-experiments

The laboratory leach data, based upon 23 CFA samples from different European sources [36], and 12 U. S. sources [38], show ranges of values indicative of variable CFA compositions and formation dynamics. The rainwater and snow data likewise show variations that for the most part are coincident with the ranges of the laboratory data. Note that dissolved aluminum is a ubiquitous feature of the post-aerial spraying rainwater and snow data shown in Fig. 5.

Photochemical air pollution has adversely affected mixed conifer forests in the U.S. most of the last century. Foliar injury, premature needle abscission, crown thinning, and reduced growth due to this type of oxidant pollution injury has been well documented in ponderosa pines and Jeffrey pines in Southern California [39]. Industrial pollution (including products of coal combustion) contributes to the reduced growth and reproduction of vascular plants, effects which may be accentuated by a warming climate [40]. Tree leaves and needles effectively collect and concentrate a significant percentage of the particulate matter in air pollution [41]. The deposition of heavy metals from particulate air pollution is implicated in forest decline in many parts of the world including North America and Europe [42].

The waxy surfaces on plants confer protection against pathogens, environmental extremes, and air pollution. One of the main barriers to the harmful effects of air pollution in conifers is the epidermal wax covering of the needles. Cuticular waxes regulate diffusion of water and gas, and their biochemistry has been widely studied [43]. The main factors affecting the adsorptive capacities of tree leaves/needles in coniferous trees are the number of stomata, the amount of epicuticular wax, and the properties of the cuticle in different seasons [44]. Particulate pollutants are able to degrade epicuticular waxes and decrease the drought tolerance of Scots pine (*Pinus sylvestris* L) [45]. Air pollution produces an amorphous appearance of epicuticular waxes in conifers, called wax erosion, which correlates with visible tree damage [46]. Cuticular wax erosion caused by air pollution destroys surface wax 2-5 times as rapidly as natural aging [43].

Pollution by CFA releases aluminum in a chemically mobile form into atmospheric moisture [36]. Aluminum toxicity by chemically mobile aluminum is one of the major factors that limit tree growth and development. Root cell plasma membranes, especially in the root apex, is a primary target of this aluminum toxicity [47]. Aluminum causes changes in the morphology of the root system, including the inhibition of its elongative growth, root callosity, reduced rootlets, and a dying away of the growth cone [48]. Exposure of *Picea abies* (Norway spruce) seedlings to aluminum in nutrient solution drastically inhibits root growth and elongation, and reduces the content of magnesium and calcium in the roots and needles of the seedlings [49]. Mobilized aluminum in soil also has a detrimental effect on plant-fungus symbiotic cooperation (mycorrhiza), which participates in nutrient supply to trees [48].

Fog is a natural occurrence along the Pacific coast of Southern California, and as noted above, is an important source of water for Torrey Pines. Fig. 6 shows an instance of heavy fog that occurred on February 9, 2018. A sample of fog water adhering to the branches of several trees was collected on a plastic tray by shaking their branches.

From its color the fog water sample shaken from the Torrey Pine branches appears to contain some occluded dust. Fig. 7 presents elemental analysis ratio-data of that sample for comparison with comparable data from a pure sample of fog water taken for mercury analysis by Peter Weiss-Penzias of the University of California, Santa Cruz (UCSC) and with a sample of rainwater from San Diego, California (USA). Although the Torrey Pine tree-shake fog water has some contamination, indicated by color, the ratios for the three samples are similar, notably all containing aluminum.

Table 1 shows the analytical data, expressed in µg/L for the three samples shown in Fig. 7. From this table one thing is immediately evident: Elements in the Torrey Pine tree-shake fog water are quite concentrated compared both to pure fog water and to rainwater.

One author (JMH), who has lived in San Diego for more than forty years, made the following observation: Often, in the morning, there is condensate on car windshields. Years ago, one sweep with the windshield wiper would clear the windshield. Since the aerial particulate spraying became a near-daily occurrence, the windshield wiper would quickly clear the moisture, but a residue would remain, requiring more active wiping and washing. It appears that some of the condensate had re-evaporated, leaving behind its residue. We posit a similar occurrence on the needles and leaves of trees. This is especially evident in the case of Torrey Pines.

Fig. 6. Fog enshrouded Torrey Pine in the center of the Reserve. Inset shows sample of fog water shaken from *P. torreyana* branches

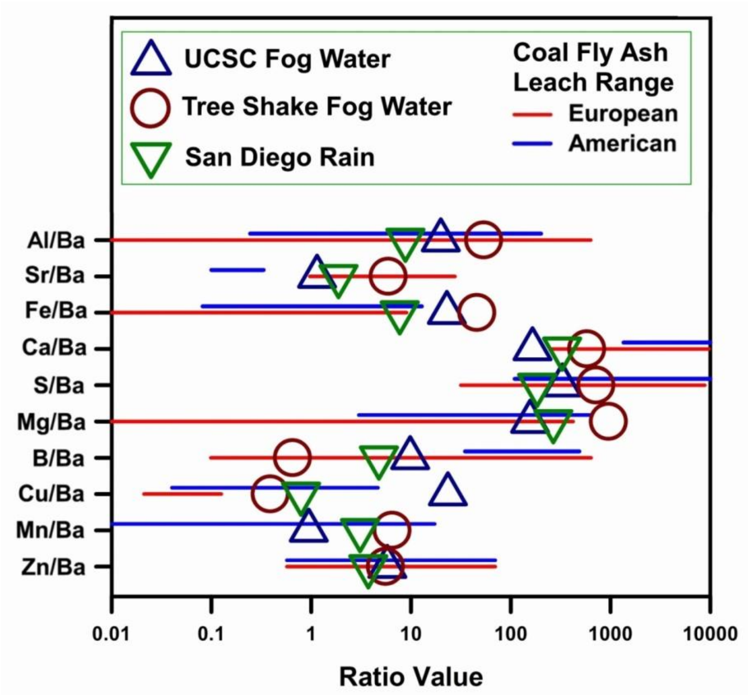

Fig. 7. Comparison of Torrey Pine tree-shake fog water with pure trapped fog water from Santa Cruz, California and with San Diego, California rainwater

Table 1. Comparison of Torrey Pine tree-shake fog water with UCSC pure fog water and San Diego rainwater. Pennsylvania snow melt data are also shown

	UCSC Pure Fog Water µg/L	Tree Shake Fog Water µg/L	San Diego Rain Water µg/L	Pennsylvania Snow Melt µg/L
Aluminum	217	26000	88.9	29.4
Barium	10.9	485	10.1	3.9
Boron	107	315	48.2	3.1
Calcium	1800	280000	3300	1500
Copper	256	189	8	1.7
Iron	250	22200	78	52
Magnesium	1700	463000	2700	ND
Manganese	10.3	3140	31.2	6.5
Strontium	12.5	2870	19	3.2
Sulfur	3590	346000	1860	230
Zinc	63.1	2700	37.8	133

The contaminant-enrichment evident in tree-shake fog water data, shown in Table 1, appears to indicate that, rather than simply trapping and directly utilizing fog water, much of the fog water is re-evaporated leaving behind its complement of CFA geoengineering contaminate-elements. This process repeatedly concentrates and re-solubilizes CFA extracts on the needles until the concentrated toxins, including and especially aluminum, falls to the ground to be taken up by the roots. In addition to poisoning the tree, the CFA accumulation on needles may adversely affect the tree's respiration.

The process of trees concentrating toxins from aerosolized CFA geoengineering activities and being concomitantly poisoned and their respiration impaired is generally applicable wherever such geoengineering occurs. This, we posit, is one of the main driving forces behind forest die-offs worldwide.

Toxins, especially aluminum, weaken trees' natural defenses against pathogens. Bark beetles, for example, have contributed to the deaths of billions of conifer trees world-wide [50]. Studies indicate that atmospheric pollution predisposes pine trees to bark beetle infestations [51]. Torrey Pines are also under threat by the California five-spined engraver beetle, *Ips. paraconfusus* [52]. It is noteworthy that bark beetles are tolerant to multiple toxic elements, including many of those found in CFA. In heavily polluted areas of Finland, trees with high levels of heavy metal in bark suffered high rates of attack by bark beetles [53]. Spruce-breeding bark beetles collected from polluted areas of Germany contained elements with high eco-toxicity including Al, Cd, Hg, and Pb [54]. Bark beetles are therefore good bioindicators for both iron and aluminum [55].

3.2 Ultraviolet Tree Damage by Aerosolized Coal Fly Ash Geoengineering

Another main driving force behind forest die-offs worldwide, we posit, is the unacknowledged, elevated level of ultraviolet solar radiation [56-59], UV-B and UV-C, caused in part by disruption of atmospheric ozone by aerosolized CFA, which contains ozone-killing chlorine in variable amounts ranging as high as 25,000 µg/g [60]. Enhanced solar ultraviolet radiation damages trees and weakens their resistance to pathogens [31].

Trees from many areas around the world are showing destructive changes in the trunk/branches and foliage which are especially prominent on sun-exposed surfaces. Fig. 8, which is characteristic of numerous observations, shows examples predominate damage on the sun-exposed side of trees. Two examples are shown. The tree on the left is a Torrey Pine, *Pinus torreyana*, on the right a Gumbo-Limbo, *Bursera simaruba*, a full-sun, drought-tolerant tree in Key West, Florida (USA).

Short wavelength ultraviolet radiation is a major abiotic stressor to trees world-wide [61]. Independent measurements document solar radiation in the range ≤ 300 nm now penetrating to Earth's surface, contrary to assertions [56-59]. Ultraviolet radiation affects trees by modifying their biological and biochemical environment [62]. The damage includes disruption of membranes and other cellular

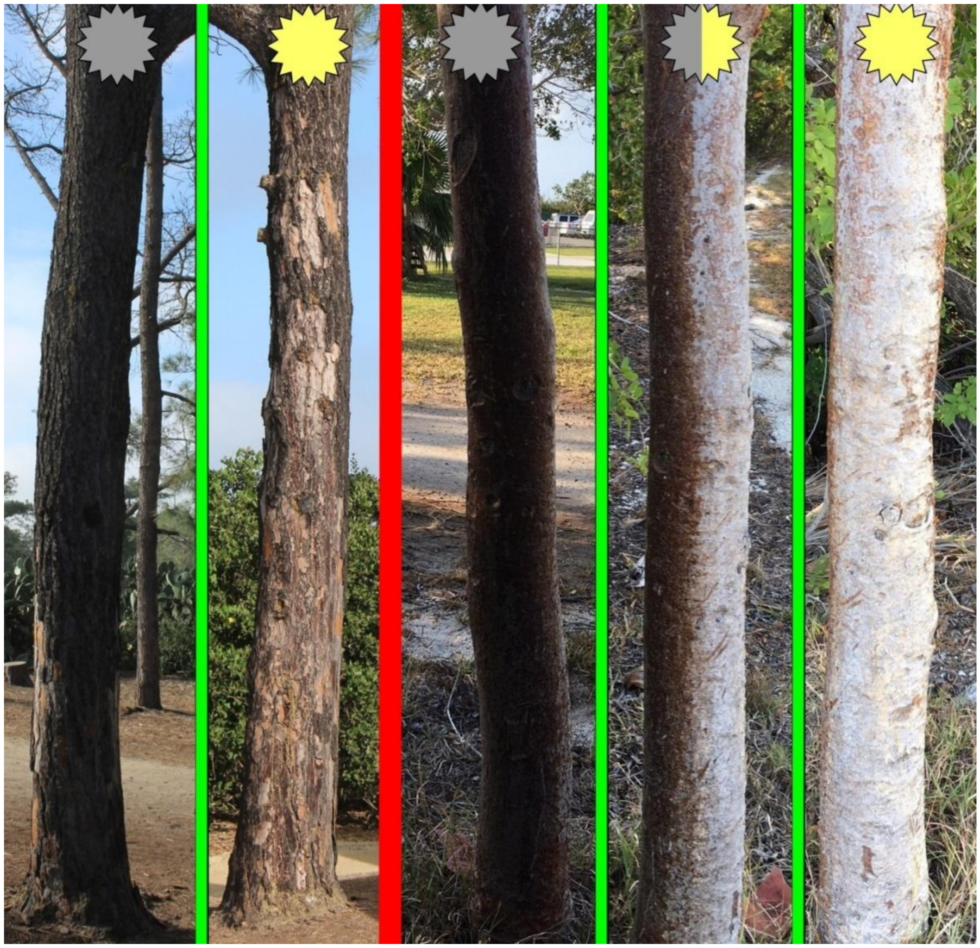

Fig. 8. Comparison of sunny and shaded sides of two trees. Left, Torrey Pine; Right, Gumbo-Limbo

structures, generation of free radicals, inhibition of physiological processes, e.g. photosynthesis, nutrient assimilation, and chlorophyll and protein synthesis, all resulting in reduced growth and development of the tree [62]. Enhanced UV-B reduces genome stability in plants [63]. A recent study shows that high UV-B intensity leads to defective pollen development in conifers associated with decreased reproduction or even sterility [64].

In recent decades there has been an unprecedented explosion in fungal diseases of trees and forests around the world [65]. Trees, we have observed, are displaying fungal growth most prominently on sun-exposed surfaces, likely indicating tolerance or even utilization of short wavelength ultraviolet radiation by these fungi. Torrey Pines are susceptible to and have been affected by dangerous fungi like *Fusarium cincinatum*, the cause of pitch canker, which can be transmitted by *Ips paraconfusus* [66]. Pitch canker is a destructive disease of pines in many parts of the world, and it is a known to be a severe threat to California pines [66]. *Fusarium incarnatum* was cultured from the whitened, sun-damaged bark of Gumbo Limbo trees in Key West by Aaron Palmateer, Ph.D., Florida Extension Plant Diagnostic Center/ University of Florida.

Although Ultraviolet C is lethal to insects [67], bark beetles presumably have some protection from UV in their habitat under tree bark.

In a recent study of the die-off of *Euphorbia ingens*, a landmark tree of South African savannas, multiple fungi and destructive insects were identified in the diseased trees [68]. The authors conclude: "These results suggest that the die-off is not related to attack of the trees by aggressive insects or pathogens, but rather *E. ingens* is under stress from environmental factors that support the ability of opportunistic insects and pathogens to establish".

4. CONCLUSION

The usual explanations of disease and death of Torrey Pines due to “drought and bark beetles” and of forest die-offs explained by “heat and drought” are over simplifications. These explanations ignore the two fundamental driving forces which we describe here, namely, the environmental stressors of toxic poisoning, especially by aluminum, and harmful ultraviolet radiation both of which are intrinsically connected to the near-daily, near-global jet-spraying of toxic coal fly ash into the troposphere and lower stratosphere. These anthropogenic stressors are causing trees to be weakened and susceptible to insects such as bark beetles, to fungal infections, and to other biotic factors (e.g. bacteria and viruses). In addition, we disclosed here a natural mechanism whereby trees’ needles and leaves concentrate toxins from particulate pollution, especially aerosolized coal fly ash for weather and climate manipulation. It may be too late to save the Torrey Pines, but if this form of deliberate air pollution is halted, some of the Earth’s forests can be preserved.

AUTHORS’ ETHICAL STATEMENT

The authors hold that technical, scientific, medical, and public health representations made in the scientific literature in general, including this particular journal, should be and are truthful and accurate to the greatest extent possible, and should serve to the highest degree possible to protect the health and well-being of humanity and Earth’s natural environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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