Original Research Article

Unacknowledged Potential Factors in Catastrophic Bee and Insect Die-off Arising from Coal Fly Ash Geoengineering

ABSTRACT

Aims: We investigate unacknowledged potentially major contributory factors in global catastrophic bee and insect die-off that arise from the use of aerosolized coal fly ash (CFA) for covert weather and climate manipulation. We also present forensic evidence that CFA is the primary material used in atmospheric aerosol geoengineering operations.

Methods: We conducted extensive literature research and additionally utilized inductively coupled plasma mass spectrometry.

Results: The primary components of CFA, silicon, aluminum, and iron, consisting in part of magnetite (Fe_3O_4), all have important potential toxicities to insects. Many of the trace elements in CFA are injurious to insects; several of them (e.g., arsenic, mercury, and cadmium) are used as insecticides. Toxic particulates and heavy metals in CFA contaminate air, water, and soil and thus impact the entire biosphere. Components of CFA, including aluminum extractable in a chemically-mobile form, have been shown to adversely affect insects in terrestrial, aquatic, and aerial environments. Both the primary and trace elements in CFA have been found on, in, and around insects and the plants they feed on in polluted regions around the world. Magnetite from CFA may potentially disrupt insect magnetoreception. Chlorine and certain other constituents of aerosolized CFA potentially destroy atmospheric ozone thus exposing insects to elevated mutagenicity and lethality levels of UV-B and UV-C solar radiation.

Conclusions: It is necessary to expose and halt atmospheric aerosol geoengineering to prevent further gross contamination of the biosphere. As insect populations decline, bird populations will decline, and ultimately so will animal populations, including humans. The gradual return of insects when the aerial spraying is stopped will be the best evidence that aerosolized CFA is in fact a leading cause of the current drastic decline in insect population and diversity.

Keywords: insect die-off, biodiversity, geoengineering, coal fly ash, aluminum toxicity, colony collapse, magnetite

1. INTRODUCTION

There is public awareness and concern [1] about the population decline of the Western honey bee, *Apis mellifera*, the principle agricultural pollinator worldwide [2]. Bumble bee populations (*Bombus*), secondary but nevertheless important pollinators, are also in decline in North America and Europe [3-5]. Evans et al. [6] investigated 61 quantified variables, such as pesticide levels and pathogen loads in *Apis mellifera* and reported “no single measure emerged as a most-likely cause of colony collapse disorder”. As noted by Watanabe [7] there is “no smoking gun.”

A recent study documented the alarming decline, 75% reduction, in insect populations (biomass) in protected areas of Germany just over the past three decades [8]. This dramatic loss of insect abundance and diversity has profound ramifications for the world-wide food web and ecosystems. In that study, neither climate change nor land use could be linked to this frightening decrease in insects, although agricultural practices and pesticide use could not be excluded as contributing factors. Like Western honey bee decline, there is no readily identifiable cause, no 'smoking gun'.

Biodiversity declines have been reported elsewhere in other species. For example, Brooks et al. [9] in the UK reported over a 15 year period that three-quarters of the carabid beetle species investigated had declined substantially. Similar declines were reported for British common macro-moths [10] and butterflies [11]. In the last 40 years, there has been a 45% decline in invertebrates, a decline that includes all of the major insect Orders [12]. No readily identifiable cause of these declines has emerged.

These investigations clearly implicate a large-scale cause of insect die-off, and point to an urgent need to discover the actual underlying cause(s) of this insect decline. Here we propose that deliberately aerosolized coal fly ash (CFA), a global and toxic by-product of coal combustion, potentially represents a major contributor to the worldwide die-off of insects.

When coal is burned, primarily by electric utilities, the heavy ash settles, while the light ash, CFA, formed in the gases above the burner, would exit smokestacks if not trapped and sequestered as required by modern regulations. Coal fly ash is one of the largest industrial waste-product streams throughout the world. Disposal of CFA is problematic; it is often simply dumped into surface impoundments or placed into landfills which cause concerns for ground water contamination and environmental pollution [13,14]. However, in many countries including the United States a significant percentage of coal fly ash is recycled into structural fill and such products as concrete [15]. Coal fly ash is also utilized in soil additives and fertilizer [16].

We have previously shown by forensic methods that CFA is consistent with its use as the primary material aerosolized for covert, jet-emplaced climate manipulation operations (Figure1) [17,18]. CFA forms as particles ranging from sub-micron to micron in size and therefore requires little further processing for use as a climate-altering aerosol. Sprayed into the atmosphere, these particles reflect some sunlight, but they also absorb energy which is transferred to the atmosphere via molecular collisions. The particles also block heat from leaving Earth's surface. The aerosolized particles inhibit rainfall by keeping water droplets from coalescing to fall as rain; the effect is to cause drought, but eventually the atmosphere becomes so burdened with moisture that storms occur with rain falling in deluges. This covert aerial spraying worsens global warming and totally disrupts natural weather patterns [19].

Here we describe additional evidence that aerosolized CFA yields toxic elements that contaminate the environment, and we discuss some of the ways which that specific contamination may potentially represent a major contributor to insect die-offs. We discuss several likely mechanisms, including toxins extracted from CFA into rainwater, and the effects of CFA particulate-components on insect viability. In addition we consider the harmful consequences of enhanced UV-B and UV-C solar radiation that concomitantly arise from atmospheric ozone reduction by aerosolized CFA.

Figure 1. Jet-emplaced weather/climate manipulation particulate trails. (Photographers with permission) Clockwise from upper left: Karnak, Eqypt (author JMH); London, England (Ian Baldwin); Geneva, Switzerland (Beatrice Wright); Chattanooga, TN, USA (David Tulis); San Diego, CA, USA (author JMH); Jaipur, India (author JMH).

2. METHODS

In the face of the obvious aerial particulate spraying, there is, however, a concerted effort to deceive the public and the scientific community of its existence and its adverse consequences on human and environmental health [20]. For the following reasons, CFA is a likely material for use in global-scale geoengineering operations: (1) It is a major industrial waste product; (2) It is produced in the size needed without much additional processing; and, (3) Its production facilities are in place, out of sight, and utilize railroad transport.

The methods for demonstrating that the aerosolized particulates are consistent with CFA are twofold: (1) Showing that the relative amounts of elements dissolved in rainwater are similar the relative amounts of elements of CFA extracted into water during laboratory leach studies [21]; and, (2) Showing that the relative amounts of elements brought down by snow, in a manner analogous to the technique of co-precipitation [17], are similar to the relative amounts of elements found in CFA [21]. Measurements, previously published and newly presented here, are by inductively coupled plasma mass spectrometry.

We conducted extensive research in the interdisciplinary scientific literature.

3. RESULTS AND DISCUSSION

Figure 2 shows a comparison of rainwater analyses with ranges of CFA laboratory leach data. Except for the Bangor, Maine (USA) data, the remainder has been published and is reproduced with permission [18]. Dilution is a variable factor that can be compensated for by using ratios, but in many cases dilution causes the less abundant elements to be below the detection limits for commercial analytical laboratories. The Bangor, Maine (USA) data, shown in Figure 2, is particularly significant as the dilution factor was low and important trace element analyses as requested were able to be determined.

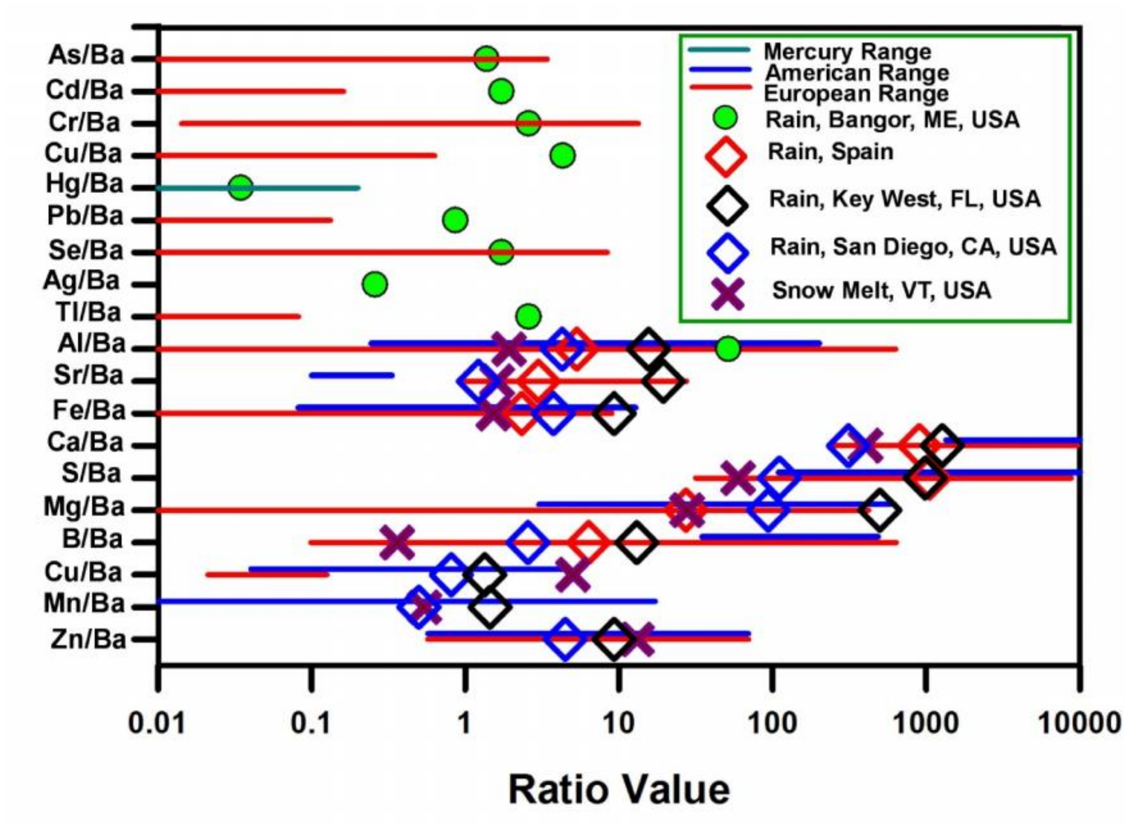

Figure 2. Element ratios measured in filtered post-spraying rainwater and snow. From [18] with permission. Rainwater data from 2011 in Bangor, ME, USA, courtesy of Russ Tanner, is newly added.

Figure 3, reproduced with permission from [18], shows analyses of aerosolized particulates brought down by snow, the residue from evaporation and the residue trapped upon underlying snow mold as the snow melted, compared with the range of corresponding CFA analyses. This figure and Fig 2 demonstrate the range of toxic elements that contaminate the environment consistent with CFA being the main aerosolize particulates used in climate manipulation.

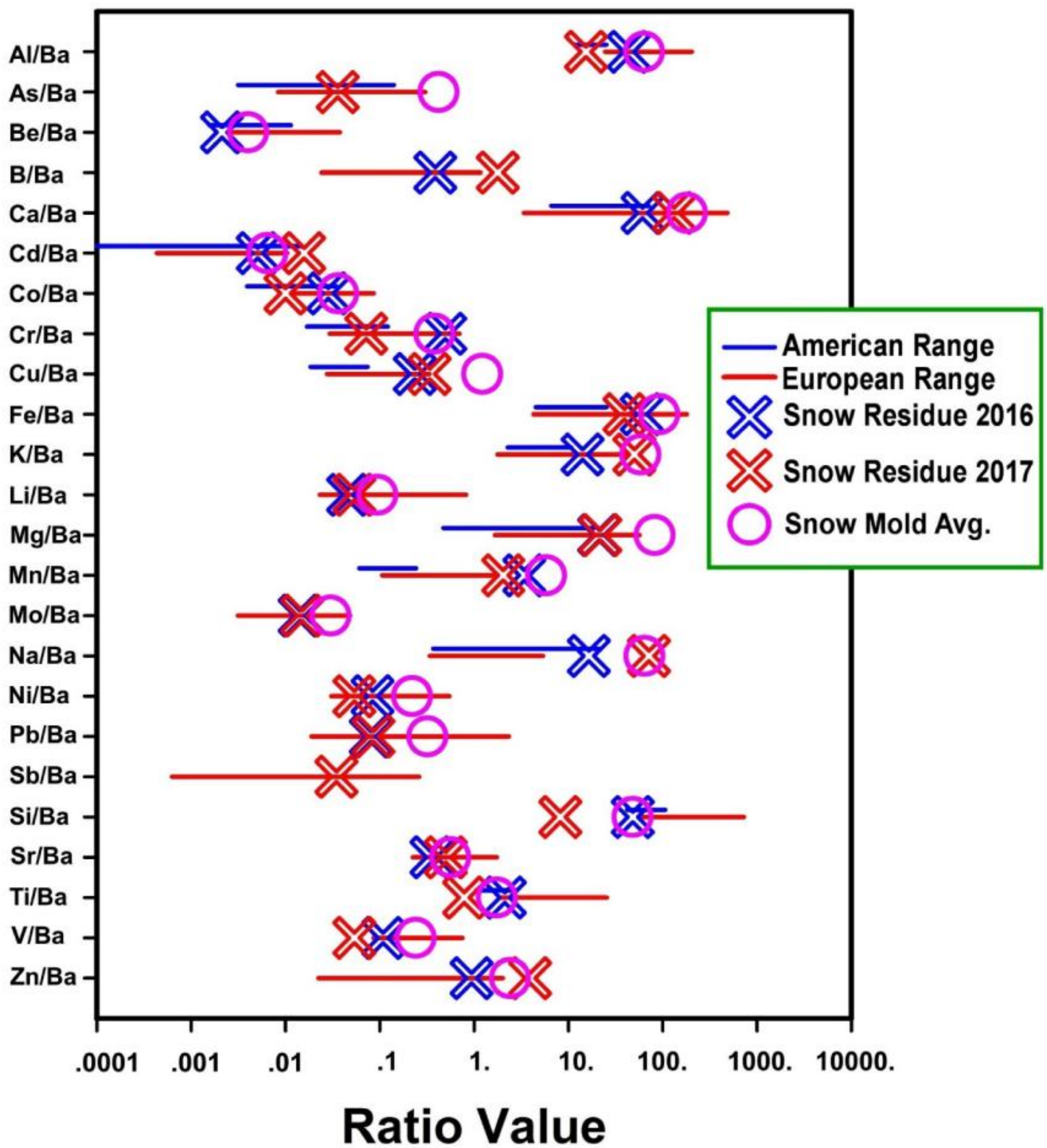

Figure 3. Element ratios measured in post-spraying snow residue after evaporation and in snow mold found beneath melting snow. From [18] with permission.

The aerosolized CFA mixes with the air we breathe and settles to Earth, hence the need for near-daily spraying. Consequently, CFA employed for climate manipulation/intervention grossly contaminates the biosphere with particulate toxic CFA and with toxins extracted from the CFA into rainwater [17,18,22].

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 alumino-silicates and an iron-bearing (magnetic) fraction that contains magnetite, Fe_3O_4. Coal fly ash is principally composed of spherical particles, including alumino-silicate and magnetite spherules [23]. The spherical configurations are due to surface tension of the melts during condensation and agglomeration in the hot gas above the coal burner [18]. Among the many trace elements originally present in coal that occur in CFA include arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), phosphorus (P), selenium (Se), strontium (Sr), thallium (Tl), titanium (Ti), vanadium (V), and zinc (Zn). Small amounts of organic material and even the radionuclides uranium (U), thorium (Th) and their radioactive daughter products are found in CFA [21,24].

Early studies of the adverse effects of air pollution on insects focused on volatile emissions including fluoride-containing gases, sulfur (SO_2), nitrogen oxides, and ozone [25]. It is now recognized that sustained exposure to particulate matter (PM) in air pollution is a major global cause of morbidity and mortality [26]. Coal fly ash is one of the main sources of anthropogenic particulate matter pollution on a world-wide basis [27]. Tropospheric aerosol geoengineering (TAG) operations, increasing in scope and intensity in recent years, represent a deliberate form of CFA-PM air pollution that also contaminates soil and water. This kind of particulate pollution can affect insects through respiration, ingestion, and direct contact. The particulate material in CFA, including metals and metalloids, are difficult for organisms to regulate, and are toxic to arthropods in various concentrations and by different modes of action [28].

Pollution caused by CFA can affect insects by bottom-up (e.g. soil or host plant quality) or top-down (e.g. direct contact or effects on predators or pathogens). A comprehensive review showed the fitness of insect herbivores was usually impacted by bottom-up factors. Fewer studies have been carried out by top-down factors, but it has been shown that air pollution does affect insect population dynamics by differential effects on herbivores and their natural predators [29]. Pollutants often bioaccumulate in predatory insects. Airborne pollution particles coat leaves and plants, affecting plant chemistry, photosynthesis, and thereby nutrition for herbivores. Contamination of soil allows for plant uptake of many elements that in turn are consumed by herbivores [30]. Coal fly ash added to fertilizer or soil can lead to potentially toxic accumulations of elements including arsenic [31].

The primary component elements of CFA, Si, Al, and Fe all have toxic effects upon insects. Deposition of Si in plant tissue provides a barrier against insect probing, feeding, and penetration into plant tissue [32]. Silicon gel, dust, and diatomaceous earth (SiO_2) removes the waxy coat of insects that preserves moisture, thus killing them by desiccation [33].

Moisture is capable of extracting aluminum from CFA in a chemically-mobile form [21]. Aluminum is usually not found in the natural world in chemically-mobile form thus there is an absence of defense mechanisms; aluminum is a non-essential metal with no biologic function. Aluminum is found in insecticides like aluminum phosphide, a highly toxic material used for grain preservation. Aluminum has been found to be toxic (causing deformities) in caddisfly larvae, with an enhanced effect in acid conditions [34]. In-vitro studies show aluminum toxicity in Drosophila flies [35]. Ingested aluminum is detrimental to foraging and other behaviors in bees [36].

As in other organisms, insects must balance opposing properties of ionic iron, that of an essential nutrient and a potent toxin. Iron must be acquired as a catalyst for oxidative metabolism, but it must be tightly regulated to avoid destructive oxidative reactions [37]. Ionic iron is one of the most reactive of all atmospheric pollutants. A biological effect common to many ambient air pollution particles is the disruption of iron homeostasis in cells and tissues [38]. Iron is known to play a catalytic role in the generation of oxygen free radicals in vitro. Houseflies fed ferrous chloride in their drinking water had shortened life spans with evidence of oxidative stress [39]. Iron accumulates in insects causing lipid peroxidation and eliciting an antioxidant response [40].

There is currently more direct evidence of pollution damage to insects from the main components of CFA. Exley et al. [41] reported that Bumble pupae from both urban and rural areas were found to be heavily contaminated with aluminum. This aluminum content was higher than levels considered harmful to humans and was associated with smaller bumblebee pupae. High levels of aluminum and other elements found in coal fly ash (Cd, Co, Cr, Cu, Mn, Se, Sr, Ti and V) have been measured in honeybees from polluted areas [42,43]. High levels of aluminum, iron and multiple other trace elements including As, Pb, and Ba have been detected in bee pollen collected from polluted areas [44-46]. Bee pollen is a mixture of flower pollen, the bee’s own secretions, and some nectar. It can be assumed that bees acquire significant amounts of metals and metalloid pollution from a “bottom-up” mechanism by ingestion of contaminated plant products and drinking water sources. In the case of bee pollen this material is brought back to the hive on the insects' legs and is one of their primary nutrition sources [44].

In addition to bees, other insects have been evaluated as bioindicators of heavy metal pollution, including those trace elements in CFA. In Pakistan, significant levels of Cd, Cu, Cr, Zn, and Ni were detected in a *libellulid* dragonfly, an *acridid* grasshopper, and a *nymphalid* butterfly. The highest levels of these elements were found near polluted industrial areas, and the lowest values (but still present) at a site far from industrial activity [47]. Accumulation of Cd, Co, Cu, Fe, Mn, Ni, and Pb were documented in grasshoppers (*Orthoptera, Acrididae*) that were collected near a copper mine in Bulgaria. Cadmium and lead were heavily concentrated in grasshoppers at the most contaminated sites [48]. Concentrations of Pb > Cd > Hg were found in food plants and grasshoppers collected from a mountain grassland 1200 m above sea level in Greece, suggesting an anthropogenic source of pollution transported in the atmosphere [49].

As bioindicators of pollution, honeybees are also used as samplers of airborne particulate matter. As reported by Negri et al. [50], honeybees foraging in polluted areas collect many inorganic pollution particles, mostly concentrated in the forewings, the head area, and back legs. These anthropogenic particles, ranging from 500 nm to 10 um in diameter, display a sub-spherical morphology and have been characterized by EDX as either Fe-rich particles or alumino-silicates. Lead and barium (both found in CFA) were also detected adhering to the body of the honeybee [50].

Coal fly ash Is a rich source of nanoparticle-sized pollution. Nano and bio-nanoparticles are increasingly being studied and employed for insect control. Aluminum, silicon, zinc, and titanium nanoparticles (all components of CFA) are being developed for crop pest management [51]. For example, nanoalumina dust can be engineered through modified synthesis to target different insect species [52]. Chemically fabricated nano-iron is being developed as an effective pesticide. It has been shown that iron and iron oxide nanoparticles are highly toxic to *Culex quinquefasciatus*, the Southern House Mosquito [53].

Recently spherical magnetite pollution nanoparticles like those in CFA, and distinct from biogenic magnetite particles, were found abundance in the brain tissue of humans with dementia [54]. Many insects (e.g. bees, ants, termites) contain biogenic magnetite and employ it for magnetoreception [55-57]. Honey bees, for example, use magnetite-based magnetoreception to detect the Earth's magnetic field by means of magnetoreceptor iron granules located in their abdomen [56]. It is therefore likely that exogenous magnetic pollution particles can disrupt these functions.

Magnetic measurements of deposited atmospheric dust serve as an additional parameter in assessing environmental pollution. Samples of this particulate atmospheric pollution contain magnetite of spherical shape, consistent with particles in the magnetic-magnetite fraction of coal fly ash [58]. Both biogenic and exogenous magnetite particles are known to be exquisitely sensitive to external electromagnetic fields [59]. Insects are continually exposed to radio-frequency electromagnetic fields at different frequencies. The range of frequencies used in wireless communication systems will soon increase from 6 GHz to 120 GHz (5G). It has now been reported that insects absorb radiofrequency electromagnetic power as a function of frequency from 2 GHz to 120 GHz [60]. There is growing evidence that exposure to cell phone radiation induces stress, and can produce both behavioral and biochemical changes in worker honey bees [61].

Coal fly ash itself has been used as a pesticide, with activity against many types of insects [16]. Many of the trace elements in CFA are quite toxic to insects. Before the development of organic/synthetic pesticides, inorganic chemicals and elements including arsenic, mercury, cadmium and boron were used as insecticides. Arsenic, cadmium, mercury and lead have no useful function in living organisms and may be toxic at any dose [62]. An insect model used to assess mercury toxicity found that mercury induces oxidative stress in insects just as it does it in vertebrates [63]. Cadmium chloride ($CdCl_2$), mercuric chloride ($HgCl_2$), and methymercuric chloride (MeHgCl) all produced marked toxicity including cell death in *Aedes albopictus* (mosquito) cells with MeHgCl > $HgCl_2$ > $CdCl_2$ [64]. We have shown that climate manipulation using aerosolized coal fly ash is likely a previously undisclosed and world-wide source of mercury contamination in the biosphere [18].

Contamination of water in lakes, rivers, and other bodies of water by chemical pollutants is one of the most important threats to all wildlife including insects. Toxic elements of CFA readily leach into water where they concentrate in aquatic plants and insects. Selenium, one such element, is an essential trace nutrient, but it is toxic in higher amounts. The development and survival of insect herbivores can be affected by even low to moderate concentrations of selenium acquired from pollution in plants [65]. Elevated levels of copper, zinc, iron, manganese, lead, cobalt, and cadmium have been detected in water and aquatic insect body samples from polluted sites [66]. These pollutants have been shown to cause both oxidative stress and genotoxicity (e.g. chromosomal breaks/damage) in aquatic infections. Even small amounts of heavy metals can change the physiochemical characteristics of water and dramatically affect the metabolism of insects [66].

Another major contributor to the world-wide insect die-off is the thus-far widely unacknowledged but independently confirmed elevated level of short-wave ultraviolet UV-B and UV-C radiation penetrating to earth's surface [67-70]. We have proposed that this increase in deadly UV-B and UV-C radiation is partially caused by geoengineering utilizing CFA, which places ozone depleting chemicals (e.g. chlorine) high into the atmosphere [70]. The mutagenicity and lethality action spectra of sunlight exhibits two maxima, both in the UV-B and UV-C region [71]. Insects are very sensitive to changes in UV-B irradiance, and solar UV-B has a large direct and indirect (plant mediated) effect on arthropods [72]. It was recently shown that UV-B influences and disrupts the metamorphosis of insects [73]. UV-C radiation (100-290 nm) is well-known to be lethal to insects [74].

4. CONCLUSION

CFA, including its use in covert (undisclosed) climate engineering operations, is a prime suspect in the world-wide decline of insects. CFA is a global source of pollution known to be toxic to insects that contaminates air, water, and soil. CFA adversely affects insects in aerial, terrestrial, and aquatic environments. Previously published data and updated in this study are consistent with CFA being the main undisclosed particulate aerosol used in tropospheric geoengineering. Recent evidence implicates CFA in the dramatic decline of insects because its primary components (alumino-silicates and iron) and multiple trace elements, are found in, on, and around insects collected in polluted areas from around the world. It would seem imperative to confirm and expand these findings and look for the "fingerprint" of CFA in rainwater, insects, and their surroundings in areas far removed from industrial sites but impacted by CFA aerosol spraying. Atmospheric geoengineering using CFA likely contributes the increasing irradiance by UV-B and UV-C radiation which is deadly to insects. It is necessary to expose and halt atmospheric aerosol geoengineering to prevent further gross contamination of the biosphere. As insect populations decline, bird populations will decline, and ultimately so will animal populations, including humans. The gradual return of insects when the aerial spraying is stopped will be the best evidence that aerosolized CFA is in fact a leading cause of the current drastic decline in insect population and diversity.

CONSENT

N/A

ETHICAL APPROVAL

N/A

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