SPIXIANA	42	1	1–5	München, September 2019	ISSN 0341-8391

Editorial

A scientist's warning: Stop neglecting biodiversity in climate change!

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The iconic "World Scientists' Warning to Humanity: a Second Notice" by Bill Ripple et al. (2017), with more than 15000 co-signers from 184 countries, identified significant physical and biological challenges to our civilization. Greta Thunberg, the "Fridays For Future" movement, "Scientists 4 Future", the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2019), as well as Bavarian voters in their highly successful referendum "Save the Bees" obviously take the loss of biodiversity seriously. Many may recognize the connections between climate change and mass extinction, while others may not care much about living creatures, plants and microbes yet. However, we all should care deeply.

The latest special report of the Intergovernmental Panel on Climate Change (IPCC 2018) has warned humanity of the consequences of climate warming beyond 1.5 °C above preindustrial levels. It presented alarming projections, e. g., if the 1.5 °C aim fails and an additional increase by just 0.5 °C occurs, the number of people affected by drinking water shortages will double, and an increase in over 1.5 billion additional people in the (sub)tropics will be exposed to life-threatening heat. We also should keep in mind that the IPCC is considered overly conservative and its reports are not merely scientific but softened by political editing. In addition, Xu et al. (2018) emphasized that greenhouse gas emissions are continuing to grow rather than showing tendencies towards reaching a plateau or decreasing; previous IPCC worst-case scenarios have already become reality. Global warming does not proceed linearly as usually modeled, but speeds up in a non-linear, exponential fashion. According to Xu and colleagues, the 1.5 °C warming will be reached a decade sooner than 2040 as predicted by IPCC; rather, we can expect this warming in 2030 with severe consequences for low coastlands, hot or impoverished regions, as well as the sociopolitical stability of affected nations at a minimum. Globally dangerous climate tipping points such as the melting of Arctic, Greenland, and West Antarctic ice, the melting of permafrost regions, or the desiccation of Amazon rain forests are being or will also be reached much earlier than expected; a climatic time bomb is ticking and any hesitation to act makes effective counteractions even less likely and increases the risk that our entire civilization collapses.

Xu et al. (2018) identified three factors accelerating the speed of global warming: 1) the ever-increasing emissions of greenhouse gases, 2) a surge in the loss of soot and other anthropogenic atmospheric particles reflecting sunlight, and 3) the responses of natural systems, e. g., changing ocean circulations such as the slackening pace in the North Atlantic current. As usual in climate change literature, biological phenomena, such as burning forests and drying or dying woods are treated as consequences of global warming or mid-term feedback systems rather than concurrently acting as a driving force (but see: Steffen et al. 2018). Here I want to emphasize the crucial but widely ignored or underestimated role of organisms in climate change.

(1) Living organisms are major sinks or sources of greenhouse gases (Cavicchioli et al. 2019). In the past, up to 30 % of all anthropogenic CO_2 may have been absorbed by plants or microbes, and this capacity supposedly benefitted from a CO_2 fertiliza-

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tion effect and lower than usual water demands for photosynthesis. However, how long will assimilating organisms cope with increasingly demanding environmental and ecological conditions? For example, in the first decade of the 21st century, two periods of drought have turned the Amazon rain forest from a major global CO_2 sink to CO_2-neutral at best (Lewis et al. 2011). At present, huge fires, more than 72 000 usually man made fires since January 2019, are devastating the drying Amazon region in an unprecedented speed and vigor. Even boreal ecosystems may fail on a large scale: 3 million hectares of taiga were lost in wildfires, possibly the largest ever, in Siberia this summer; huge Canadian forests have been producing more CO_2 than they have been absorbing for the last 15 years (92 megatons in 2016) because of unintended deforestation by wildfires, parasitic insects, stress by heat and drought, and enhanced dissimilation under warmer conditions.

According to a report by ARD Tagesthemen (2019), such additional greenhouse gases are not taken into account in any official CO_2 budgets or statistics. Other industrial countries handle – or hide – such “natural” CO_2 emissions in a similar way. In addition, plant material has been deposited over thousands of years in thick layers in huge Arctic permafrost regions, accounting for around a quarter of the land surface in the northern hemisphere. Driven by hot summers, permafrost soils are melting much faster than expected and massive greenhouse gases such as methane and CO_2, but also nitrous oxides are being released by microbes decomposing the organic carbon; as the heat increases this decomposition may accelerate. It is a fact that methane concentration in the atmosphere is rising much faster than expected. On a global scale, diverse natural forests, humous soils, and peatlands are being overexploited, decomposing, and degrading. An honest and critical survey on “natural” terrestrial greenhouse gas emissions is overdue.

The oceans are said to have absorbed another 25 % of anthropogenic CO_2. This capacity may decrease; however, because warmer and more stable superficial sea layers take up less CO_2 from the atmosphere. CO_2 makes sea water more acidic and a lack of carbonic ions is a problem for calcifying organisms which used to be a major sink for CO_2. No less than half of the atmospheric oxygen may be generated by photosynthetic activities of marine organisms (Cavicchioli et al. 2019), which means binding CO_2 in body mass, part of which will sink into the deep and be out of reach for hundreds or thousands of years. However, oceans are being more and more overexploited and polluted and ocean life is in a miserable condition: coral reefs are dying, calcareous shells are corroding and ocean plankton as a whole may be changing to a less productive or CO_2 mitigating composition. The Earth is a blue planet; marine ecosystems are the largest and among the most endangered, but the role of marine life for climate change is as of yet poorly understood and likely much underestimated.

None of these more massive, global and faster than expected changes driven or caused by organisms is commonly modeled or reflected in climate projections yet, but they all contribute hugely to greenhouse gas balances and thus, global change in short-, mid-, and longer terms. Boreal and tropical forest systems, soils, permafrost, coral reefs, and open sea ecosystems all are tipping elements in the climate system (Steffen et al. 2018), and all are in the process of crashing right now or may collapse very soon. No doubt, the biodiversity crisis and climate change are twins, building up several deadly feedback loops. Both crises need to be resolved if we want to have a future for ourselves and our children.

(2) Living organisms are more sensitive indicators and more often victims of climate change than expected. The recent, repetitive bleaching of most of the global coral reefs along with their increasingly pessimistic prognoses of survival and eventual failure (UNESCO 2017), the discovery of co-extinction enhancing species loss (Strona & Bradshaw 2018), the massive decline of insects even in protected areas (Hallmann et al. 2018, Segerer & Rosenkranz 2018), and the collapse of animal biomass even in untouched tropical forests (Lister & Garcia 2018) are just some examples of grave and potentially irreversible biodiversity losses that were discovered or came into scientific and public consciousness recently. Losses are dramatic and sudden, and mechanisms are logical and obvious even to laypeople: when habitats are destroyed or polluted, or environmental conditions become hostile, habitat-building trees, mosses and corals die, and the associated animals, plants and other organisms usually die as well. There can be no doubt that we are in the midst of the sixth mass extinction and this time it is man-made. There are virtually no foreseeable and efficient counteractions, so we may expect vicious dynamics to increase and expand to other natural, diverse and remote regions: there will be no escape for much of the (mostly unknown) diversity of life on Earth. On a more general level, ecosystems with an ever-decreasing diversity and poor resilience are prone to collapse and result in less-productive conditions with poorer numbers of species, and they become increasingly ill-suited to provide any kind of resources to humans.

(3) At present, the major threat to living organisms and their state of biodiversity may be caused by us humans directly or indirectly destroying, poisoning and overexploiting vast parts of lands and sea rather than by climate change. On the one hand, this could be favorable news since theoretically we could still quite easily stop such habitat destruction, restore nature and store or avoid greenhouse gases naturally. Sadly, the exact opposite is happening: tropical deforestation has dramatically sped up in the last few years (www.globalforestwatch.org). On the other hand, mass extinction by climate change comes in addition to conventional biodiversity loss, and this process will clearly speed up exponentially. The true scale of mass extinction is still unknown, since little research has been done in the most diverse regions such as (sub)tropical forests; and this research usually concentrates on just a few relatively species-poor taxa such as birds or other vertebrates. Basically, with around 1.5 million animal species described and named, we do not know whether 2 or 20 or even 100 million animal species still exist, nor do we know their distributions, abundances, physiological needs and tolerances, abilities or roles in the ecosystems. In the absence of basic taxonomic and ecological information, we cannot know how many species have disappeared, are currently endangered or will soon go extinct (Schrödl 2018). There is a painful ignorance of life on Earth!

(4) Living organisms are the most vital and frail elements of ecosystems and thus of our civilization. In our industrialized world we think that we are masters of our existence, that ecological thinking is a luxurious afterthought of economic wealth, and that climate change is the most urgent and important environmental problem. But every day we still fully depend on natural resources provided by living organisms, e. g., on clean air, drinking water, food, natural products for healing or heating or construction, green environments for relaxation, sports and recreation, and so on. We fully and directly depend on ecosystem services derived from fertile soils, assimilating and evaporating plants, fungi and animals recycling nutrients, whether we like it and realize it, or not. We 7.6 billion humans fully depend on other life forms which we are destroying on larger than ever scales and more efficiently than ever before (Ripple et al. 2017). But we still ignore these trivial facts, in public and in science!

(5) We are running out of time, not only or primarily because of carbon budgets, but because the onslaught of death is already rapid, disastrous and irreversible. Climate change, per se, is rather slow, greenhouse gases can be measured and the future can be modeled on an ever improving data base. Biological tipping points; however, are poorly researched and understood, because we do not know the organisms, their needs, interactions and resiliencies. Timings of ecosystem collapses are rather unpredictable, they can be triggered this year or the next, suddenly and fiercely, and they can proceed not only exponentially but in cascading, catastrophic dimensions. Coral reefs are dying at exactly this moment and experts doubt they will ever recover. Dying reefs quickly become depleted in species, beauty and productivity; local people lose their main food source and income from tourists. Dead reefs also quickly erode and lose their function to shield coasts from wave energy. Hundreds of millions of people will lose their lands and homes solely because of dying animals – colonial reef-building corals. Logging enhances erosion, soil degradation and desertification, and thus increases poverty and hunger for millions of people. But have you heard that the successive desiccation of the Amazon basin not only shuts down regional evaporation and rain dynamics, but also is likely to hamper moist air flowing in from the Atlantic and finally streaming to the south, bringing rain to the huge agriculture lands of central and southern South America? What a risk for half a continent and many millions of people, just by burning, cutting or drying trees far away! Such disasters in nature will inevitably lead to disasters in societies with the poorest suffering the most; migration, destabilization of economic and political systems, and wars will be the consequences. Not in a distant future but soon, within one or two, maybe three decades, if we continue with business as usual, as it seems we will do. The climate bomb has a biological time fuse.

To sum up, (down)playing the numbers and climate projections into the distant but highly unlikely-to-reach future, i. e., the year 2100, it seems likely that thousands of scientists with millions of instruments and billions of dollars and data points may have underestimated the simple fact that there are always going to be more humans in direct need of sufficient water and food from a healthy and diverse biosphere – which is critically endangered by a man-made global mass extinction. Nature is in a disastrous condition, the last IUCN council has stated, with no indication of turning around this deadly trend I could see (Schrödl 2018). This biological crisis boosts climate change and climate change boosts extinction. We are running into a “biocalypse“ right now.

Yet, equally ignored, living organisms such as plants, animals and “microbes“, as well as research regarding their biodiversity could play a major role in saving us and the future of our next generations. We should stop destroying, poisoning and overexploiting nature now! This will help preserve CO_2 sinks rather than convert them into sources. We should stop any deforestation of primary forests and preserve those forests likely to be resilient to climate change. We should plant at least 1 trillion trees in deforested and often devastated and degraded areas of the tropics alone to stop droughts, erosion and desertification, to boost biodiversity, and to sustain local people. Not new? Ineffective? Unrealistic? A recent paper by Bastin et al. (2019) considers 900 million hectares of land to be available for immediate reforestation on a global scale, without any conflicts with agricultural or urban areas already used by humans. Half a trillion additional trees would absorb no less than one-third of the total anthropogenic carbon dioxide – if planted soon and assimilated over several decades. No more excuses, please. We also should preserve moors, reefs and mangroves and any other carbon-storing and life-preserving havens worldwide, and we should restore and care for such habitats.

All of these measures will initially require a large investment, but in turn we will save much more money and give meaningful and permanent work to billions of people in remote areas. We need to switch to organic agriculture globally, minimize wasting food, reduce the consumption of animal products, and we should do our best to revitalize soils worldwide. By reforestation and the natural enrichment of soils with carbon alone we could bind tens of gigatons of CO_2 per year and help reach a global net of zero greenhouse gas emissions without overshooting the 1.5 °C aim. Working with nature instead of destroying it, there would be no need for costly and inefficient technical CO_2 recovery or risky geoengineering to save the climate (while destroying life anyway). Researching the diversity of life, taking inventory and describing all of the species on Earth would be beneficial in many ways; e. g., we would learn what there is out there, how it benefits us, and what we risk losing; we would give names, faces and histories to millions of fascinating creatures and feed the press and public with novel and feel-good stories of life, discovery and adventure; we would establish a great international and collaborative mid-term goal for mutual benefit (Schrödl & Häussermann 2017); and by additionally sequencing genomes we would enhance cutting-edge biotechnology as well as benefit from multitudes of natural products and services (Lewin et al. 2018), leading not only to economic wealth but better health and living conditions for everybody.

We should realize that we are living organisms depending on a multitude of other living organisms every single day, that these diverse elements of life and ecosystems are critically endangered and sensitive to sudden collapse right now, and that we must preserve the climate <u>and</u> biodiversity – not only climate <u>or</u> living nature. Civilization needs to be decarbonized as soon as possible. The necessary transformations can become life-saving measures if performed in a socially responsible way: researching, preserving and restoring nature can be of enormous and immediate help. Change is coming and no technological advance is expected or will be required to save ourselves and life on earth. The question simply is: are we foolish enough to continue destroying a billion years of evolution on Earth and ourselves within the next generation, or will we be clever enough to save nature, the climate and ourselves? I am optimistic that we could turn the deadly trend around, if we really wanted to, because we have not even seriously started doing even the simplest things such as considering biodiversity in climate change.

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