SEAWEEDS AND THEIR ROLE IN GLOBALLY CHANGING ENVIRONMENTS

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Seaweeds and Their Role in Globally Changing Environments

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PREFACE

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Climate changes and global warming occurring on earth are now a widely recognized phenomena within the public and scientific communities. They will likely modify marine life dramatically as we now know it. One critical question regarding these changes is whether they occurred because of human intervention, or due to natural events on earth, or a combination of both. Irrespective of the source of these changes, it is our responsibility to understand and properly control these events so as to diminish potential or irreversible damage in the marine environment. The goal of this project, *Seaweeds and Their Role in Globally Changing Environments* was to emphasize the role of marine macroalgae, the so-called seaweeds, within the context of global changes occurring on planet Earth.

This book concentrates on the diverse aspects of the expected effects of global changes on seaweeds. First, a general overview of current changes in the oceans is given including the legal aspects associated with these modifications. While responses to global changes occur first on a species level, ultimately the modifications will arise on a community and global ecosystem levels. These aspects are discussed in Part 2. Then, Part 3 addresses short- and long-term seaweed ecophysiological responses to environmental abrupt changes, which forces marine plants to make sudden adjustments rather than adaptation processes that have occurred during millions of years of evolution. Specific and detailed aspects of seaweed responses to the UV rays are given in Part 4. Applied aspects of seaweeds follow in Parts 5 and 6. Here, the reader will find insights of potential uses of seaweeds in the future, and expected effects on seaweed cultivation practices worldwide as dictated by the globally occurring changes in the marine environment. Theoretical approaches of marine plants utilization in the future as related to modified environments are shown in Part 7. Global changes influence almost all aspects of human life, becoming daily worries/issues within the general public and scientific community. The need to enroll synergistic forces to address the problems derived from global changes and their environmental effects is apparent. Therefore, we have considered pertinent to also include spiritual/religious approaches to

the issue, which are quite unique in the scientific literature. These aspects are analyzed towards the end of the book and may allow to those readers interested in such aspects of life as well.

The book begins with rather pessimistic overviews of anthropogenic and natural effects on the marine environment. Although predictions may be quite devastating, contributions presented by experts show much optimistic pictures of how the marine macroalgae will look like in terms of their ecological communities and adaptation strategies. Further, seaweeds will have a much more significant role in controlling environmental stresses caused by global change. Thus, the reader will be transferred through various levels of comprehension both scientifically and encouragingly as to how will seaweeds be viewed in the near future.

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INTRODUCTION TO GLOBALLY CHANGING ENVIRONMENT

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1. Weather Changes in the Past

Archeological evidence for weather changes in the past are seen in the discovery of traces of agriculture and tropical plants (bones and fossils) in desert areas. Other evidence demonstrates the inundation of settlements that today are beneath the sea. Finding marine traces and fossils at high altitudes, such as hill tops, and in other dry zones climate changes supports this assumption. Some scholars have assumed that global warming during the biblical Noah's generation may have caused the flood. Others view the Egyptian atmospheric plagues toward the exodus of the children of Israel and the splitting of the Red Sea as related to climate change by nature.

The release of current industrial pollution and other sources into the atmosphere and hydrosphere has increased at a far greater rate than any historic natural process. One serious regional environmental problem is acid rain. As long as we have been burning fossil fuels, this acidic liquid has been falling from the sky and causing damages.

Even with the biological removal of pollution caused by $CO_{2,}$ which also causes atmospheric warming, the pre-existing state cannot be regained precisely. So, global warming is accelerating faster than the ability for natural repair. Lately, it has been determined that there is no link between global warming and cosmic rays or other solar activities.

2. Current Human Activities and Their Influence on the Climate Changes

A new NASA-led study shows that human-caused climate change has made an impact on a wide range of Earth's natural systems, resulting in permafrost thawing, acid rain, plants blooming earlier across Europe, and lakes declining in productivity. Researchers have linked varying forces since 1970 with rises in temperatures. Humans are influencing climate through increasing greenhouse gases emissions, among them are CO_2, N_2O, CH_4, CF_3, and CFC. Global warming is influencing physical and biological systems all over our planet but most specifically in North America, Europe, Asia, and Antarctica.

Climate change is one of the greatest challenges the world is now facing. Leaders should now deal with this disaster by calling for long-term international development programs. The ecology factors driven by man include industrial fuel

burning that yields by-products and pollution spills, vehicle emissions, smoke from power stations' chimneys, huge fires, and other harmful environmental activities. All those occurrences may intensify the greenhouse effect, cause changes to climate, and directly harm global biology. Further damage caused by man includes deforestation in some developing areas. The felling of millions of trees in areas like the Amazon rain forest in addition to forest fires will reduce the green lungs of the globe. Likewise, damage could result from excess grazing by herds, excess pumping of water, and desertification. Some gases (such as CFC) released by industrial activities damage the protective screen of the stratospheric ozone layer (as, e.g., the recently discovered ozone holes over Antarctica) and cause intensive UV radiation to penetrate to earth in higher doses.

Some predictions claim that with global warming we shall have less rain and less precipitation. Or, rain will arrive in short, strong storms, so that the precipitation will not penetrate into the subsurface accumulation spaces. Such an effect would reduce and damage the subsurface water reservoirs. Others see no rain, drought, the drying out of large water supplies, dust storms on a great scale, and general damage to agriculture. All these will damage more and more genera of living creatures. There are also contrasting harmful effects, such as heavy rains and floods, or hurricanes in certain zones around the globe; intensified and ruinous damage from storms; thawing of glaciers; and the rise of sea levels, with the danger of over flooding to low lands.

The rise in temperature will influence the evaporation rates in lakes (see the current case of the drying Dead Sea [Israel], Chad lake [Africa], or Aral lake [in Asia]), which might shrink and almost vanish without sufficient income of water from their sources. Global warming also poses a severe danger for some animals, such as, the polar bear that is in danger of extinction, or the harm caused by the expansion of fire ants to areas once too cold for them. Warmer and more acidic oceanic water (due to the increase of CO_2 in the atmosphere and oceans) spells trouble for jumbo squids and other marine animals. Global warming might cause a reduction in the amount of dissolved oxygen in the oceans and lead to suffocation of marine biota. Results, for example, would be that the tuna and sword fish would turn into extinct species and corals would be harmed, resulting in the disappearance of several species of fish and reefs.

Trees in western North America are dying more quickly than they used to, but there is no corresponding increase in the number of new seedling trees. Mortality rates, which are currently of the order of 1% a year, have in many cases doubled in just a few decades. The increased mortality correlates with climate change in the region, which has warmed by an average of between 0.3°C and 0.4°C per decade since the 1970s.

Some experts claim that even if carbon emissions were stopped, temperatures around the globe would remain high until at least the year 3000. And if we continue with our current carbon dioxide discharge for just a few more decades, we could see permanent "dust bowl" conditions.

3. What Should Be Done to Curtail Human Actions That Promote Global Warming?

The responsibility of the community is to avoid desertification and repair it. There should be a shift to growing crops which need less irrigation, and the burning of large amounts of fossil crude oils and coal should be avoided by using alternative energy sources. Nations should carefully manage the consumption of fuel by the various vehicles (cars, boats, air planes, and power stations). They should maintain restrictions on deforestation and seek alternative sources of usable water (for human needs and agricultures).

4. Algae, Seaweeds, and Global Warming

Microalgae and seaweeds (see further) have enormous potential and are actively involved in lowering global warming and climate change. Algae and seaweeds (like the entire green world) absorb carbon dioxide from the atmosphere (or directly from their solution media) by the process of photosynthesis, release oxygen, and produce solar biofuel. During photosynthesis algae (and higher plants) grow; they actually drain CO_2 from the atmosphere. This gas is released again when their biomass burns. This CO_2-capturing system within the green world keeps this gas from re-entering the air (except for minor amounts released during the plant–animal respiration process). In fact, even the plant residue (e.g., the ashes) could be put to good use as mineral-rich fertilizer after being pressed into biofuel.

Marine macroalgae (seaweeds) play significant roles in the normal functioning of atmospheric environments. Even though seaweeds are restricted to the tide zones and benthic photic zones, they contribute to about 10% of the total world marine productivity. Ecologically they account for food and shelter for marine life. Seaweeds are also used as sea-vegetables for food consumption (for fish and man). In the Far Eastern countries they use *Porphyra* blades (Nori) in cuisine. In addition, elsewhere other edible seaweeds are in use, such as *Rodymenia* (Dulse), *Laminaria saccharina*, *Chodrus*, and *Ulva* (sea lettuce). There are other uses for seaweed since it is rich in vitamins, minerals, and proteins. Various marine macroalgae are potential sources of bioactive compounds, and they act as antibacterial and antiviral agents. Among them are those that may also be utilized for the treatment of human diseases such as cancer.

Globally changing environments on earth is more likely to severely modify the current equilibrated terrestrial and marine ecosystems. Specifically for the marine environment, global changes will include increased carbon dioxide which will acidify the aqueous media. It has been estimated that for CO_2, the change might be from the current 350 ppm to approximately 750 ppm within 50 years, or so. Such a difference will cause higher average seawater temperatures (within 1–3°C) and higher UV radiation on the water surface. These changes will affect marine macroalgae at different levels, namely molecular, biochemical, and

population levels. While predictions of altered environments have been studied extensively for terrestrial ecosystems, comparatively much less effort has been devoted to marine habitat. Seaweeds may contribute significantly to reduce pollutants (such as CO_2, heavy metals, and excessive nutrients disposed of in the marine environments).

5. What Should Be Done to Reduce Greenhouse Gas Emission?

5.1. NO NEED FOR REDUCING THE GREENHOUSE EFFECT – FALSE PANIC ALARM

Historic records extracted from deep ice cores (taken in Antarctica drilling) show that quantities of CO_2 have varied widely in the last hundreds or thousands of years. This evidence appears to contradict the current critical view of global warming. Some voices claim that the present observation of the human-induced greenhouse effect is actually a natural occurrence. They say that the effect of carbon on the climate is overestimated and the climate crisis might be hyped. However, a new study shows that although carbon dioxide levels may have been larger in the past, the natural processes had time to react and counteract global warming.

5.2. DO IT NOW

Only good education and international enforcement applied to governments will reduce the pollution in our planet. The less greenhouse gases released to the atmosphere and hydrosphere (by various human sources), the greater and faster will be the salvation to the problem of global warming.

6. Conclusion and Summary

There are pro and con arguments about global warming and its damage to the earth's atmosphere. As a result of continuing pollution, we might witness the warming of the atmosphere, changes in the precipitation, and an increase of the CO_2 level in the atmosphere which might also cause acidification of the oceans. The elevated temperature causes the thawing and melting of the glaciers, which will raise the sea level and cause overflooding overfloating and drown the nether areas (under the sea level). Other hazards are the lowering of ground water and the salting of the aquifers near the sea shores, reducing drinking water and agricultural irrigation, desertification of large green areas, and increasing doses of UV harmful irradiation.

Activities should be designed to prevent most of the dangerous phenomena noted above; one such possible endeavor would be the search for an alternative energy source (rather than black gold or coal). A main target is utilization of

alternative sources of energy, such as solar and wind energy, hydroelectric power, and "ocean energy" (using underwater vibration) for various human applications. These powers should reduce and avoid the spread of harmful gases. In some cases, the use of uranium could also be implemented as an energy source, but this means must be instituted very cautiously. Another aspect is a stricter watch over fires, and the maintenance and increase of the areas of rain forests. But above all is the education of the present and future generations to keep our Mother Earth as pure as possible.

Biodata of **Joseph Seckbach**, co-editor of this volume and author of ***"Introduction to Globally Changing Environment"***

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PART 1:
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