Mar 17, 2012

Floating prairies of the sea could help solve global warming

Posted by Daniel Berleant in categories: biological, biotech/medical, engineering, futurism, sustainability

Executive summary. By increasing the biological productivity of the vast ocean waters, which cover 3/4 of the Earth's surface, photosynthesis could remove a lot of carbon dioxide from the atmosphere, helping to control global warming.

The nutrition problem. The main things vegetation needs – water, oxygen, and carbon dioxide – are readily available from the ocean and atmosphere. Nitrogen is critical as well, is present as 78% of the air, and can potentially be extracted from the air and chemically transformed into biologically usable form by advanced biochemical pathways. Legumes (such as beans) do that on land already with the assistance of special bacteria living in nodes on their roots. This helps to account for the success of the legume family. This proves it can be done and therefore that seaweed could potentially do it someday.

Iron. Smaller quantities of various minerals are also important. For example iron, an essential trace mineral for plants, is in short supply in many parts of the ocean and this limits algae growth. Indeed, it has been proposed that iron-containing fertilizer could be dispersed in iron-deficient ocean regions as a way to stimulate so much algae growth that atmospheric carbon dioxide levels would be significantly affected, helping to control global warming. Since algae and other photosynthetic organisms take in carbon dioxide (and output oxygen) this is a sensible strategy. In fact, every naturally occurring element is present in sea water even if the concentration is too low, as in the case of iron in many areas. More gold than King Midas ever dreamed of is dissolved in every cubic mile of seawater! Not that vegetation needs gold, but everything it does need is there to be extracted from the water. The problem is that growth is limited by the low concentration of key substances. Vegetation will need to solve this if it is to become densely packed on the ocean surface, but it can be done.

Getting more nutrients. Reduced to the basics, the problem is that modern floating seaweeds can access dissolved nutrients only very close to the surface, because that is where the seaweed is. But if they could get to nutrients present down as far as 10x deeper than they can now, they could get 10x as much nutrients. What is needed are long, thin root filaments that descend into lower waters, take up the nutrients down there, and transport them up to the floating seaweed at the surface. Such roots will be genetically engineerable once the genetic coding language is deciphered and genetic engineering becomes a subfield of software engineering. (Alternatively they might evolve of their own accord, given enough millions of years.) What would it take to grow such roots? To get an estimate, suppose a root filament has a dry weight per inch which is the same as a human hair, roughly 0.05 milligrams per cm. Its thickness in water would be greater than the thickness of a hair, because to be alive the root filament would need to contain water as a large part of its volume. However, at 0.05 mg/cm of dry biomass, that is about half a gram for a root filament the length of a football field. Descending downward into the ocean, it would contact a lot of water from which nutrients could be extracted and transported upward to the seaweed. For a significantly sized floating seaweed clump, only half a gram of biomass (less than a fiftieth of an ounce) is not that expensive to grow, and may be well worth the effort considering the benefits even one such long root fiber would have for taking in nutrients. Of course, a root shorter than a football field would be even cheaper to grow, and probably still long enough.

The mobility problem. To have a hope of covering any ocean surfaces, floating seaweeds will need to confront the fact that anything floating on the ocean surface is subject to motion from currents and winds. Any such forces that lead to steady motion in one direction will result in landfall in too short a time for

floating seaweed to grow in massive quantities. Thus floating prairies will only appear in locations that either remain stagnant, unaffected by currents and winds, or circulate in a repeating loop (called gyres). The most obvious qualifying body of water is the Sargasso Sea. Other areas are known as the Great Pacific Garbage Patch, the North Atlantic Garbage Patch, and the Indian Ocean Garbage Patch. These are oceanic areas where a high concentration of small particles of plastic accumulate in the water where they are deposited by surrounding currents. If plastic trash can build up, the water is stable enough for seaweed to accumulate as well. Thus floating prairies of seaweeds or other vegetation (such as salt-resistant water hyacinths created by genetic engineering soon, or eventually evolving naturally over the vastness of time) could develop in those areas, reaching out of the water to form apparently solid meadows that hide the water beneath. Colonization by the smaller land creatures would follow naturally, as they could climb among the prairies without falling through and drowning.

Conclusion. By increasing the biological productivity of the vast ocean waters, which cover 3/4 of the Earth's surface, photosynthesis could remove a lot of carbon dioxide from the atmosphere, helping to control global warming.

Reference: "To get an estimate, suppose a root filament has a dry weight per inch which is the same as a human hair, roughly 0.05 milligrams per cm." M. Legrand, C. Passos, D. Mergler and H. Chan, Biomonitoring of mercury exposure with single human hair strand, Environmental Science and Technology, 2005, vol. 39, pp. 4594 – 4598. www.unites.uqam.ca/gmf/caruso/doc/caruso/passos/legrand_2005.pdf

Tag: seaweed

11 comments

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Comments so far

- *Sylvia A. Earle* on March 17, 2012 7:47 pm

  Disrupting the systems that presently shape Earth's life support functions is risky business. The "floating prairie" idea, if implemented, will harm, not help, the nature of the ocean. Eliminating stress on natural systems is the best hope for stabilizing the circumstances that keep us — and the rest of the living world — alive. How about devising solutions for eliminating the accumulation of plastic in the sea rather than adding new problems?

- *Mike Lorrey* on March 17, 2012 8:35 pm

  I was actually going to suggest engineering a seaweed that feeds on plastic, directly or indirectly via some symbiote, tho you'd then have to worry about the resulting organism attacking the hulls of every composite boat out there.… That said, CO_2 is not a direct cause, but an effect, of natural warming. CO_2 rose over the 19th and 20th centuries as a biological response to the end of the Little Ice Age. CO_2 rises always LAG after warmings by a century or so. Human CO_2 contributions account for only a few percent of the total CO_2 in the air/water system of Earth.

- *Patrick Takahashi* on March 17, 2012 10:40 pm

  In my long career in this field (taught environmental engineering and was the campus ecologist of the University of Hawaii, helped write the first OTEC bill when I worked in the U.S. Senate, chaired the first international workshop on marine options for remediating global warming, organized the team for the NSF Marine Bioproducts Engineering Center, etc.), I observed that viewpoints differed from those who only wanted to protect the ocean to those hell bent on developing the riches of the seas. I like to think that there must be an optimal pathway to intelligent and productive utilization of the oceans in harmony with the marine environment. Click on Blue Revolution Hawaii (http://bluerevolutionhawaii.blogspot.com/).

  Dear Daniel, would like to hear from you (ptakahas@hawaii.edu). Sylvia, trust all is well.

- *Professor Garry E Hunt* on March 18, 2012 2:51 am

  You cannot play with the Ocean alone and expect to be able to change the climate in a beneficial manner. The Ocean is just part of our planet's climate system and all the parts are interconnected. This is an unworkable proposal.

  —
  Blogger response:
  "This is an unworkable proposal."
  Well…that's a pretty strong statement…can you prove it?

- *Dr. Paul J. Werbos* on March 18, 2012 4:52 am

  It's not quite so simple. Humans are already fertilizing the ocean to an unprecedented extent — agricultural runoff, leading to lots of photosynthesis which then leads to eutrophia and anoxia.
  The greatest climate change worry, in my view, is not warming as such but the risk of changes in ocean currents (see Peter Ward, Under a Green Sky, and the original work by Kump which he cites). If the northern surface warming currents in the Atlantic do slow down, and the reverse deep currents oxygenating the ocean also slow… the trigger for mass death, in my view, would not be acidity but anoxia and eutrophia. But perhaps events in the Black Sea will give people some warning before it becomes too late. Maybe. Just my opinion, not representing any of the folks I work with.

- *Daniel Berleant* on March 18, 2012 9:44 am

  Patrick, hope you got my email…DB

- *Patrick Takahashi* on March 20, 2012 1:32 am

  Dear DB:

  No, I don't remember seeing anything. Try the above e-mail address.

Aloha.

Pat

- *Tom Kerwick* on March 20, 2012 6:57 am

  Good to see such a well prepared post here on Lifeboat. It is true that the real ‘lungs of the earth’ are the algae of the oceans and not our rainforests, and so strategies to increase their effect, such as the introduction of GM algae to our seas should be given due consideration. Not only do you state this, but you also offer strategies how such algae could be genetically enhanced and positioned to maximally do so.

  However — you do not address the environmental impact of such — whether it would have an adverse effect on marine ecosystems, and for this reason, I would be hesitant to using a thriving ecosystem such as the Sargasso Sea for a trial run of such GM algae. There are many locations around the world more suitable.

  Also, a passing thought — as such GM algae may be of interest to the biodiesel industry — perhaps this industry is an avenue which could drive such an idea forward…

- *Daniel Berleant* on March 20, 2012 10:00 pm

  Yes, the unforeseen side effects of such geoengineering projects is a concern. So a trial run would seem like a good idea, but then, how could there be any guarantee it wouldn’t spread out of control?

- *Tom Kerwick* on March 22, 2012 3:11 am

  Yes, there would be risks introducing such to the open seas without trial, as it would be difficult to contain if the growth got out of hand and had advsere effect on the ecosystems… However, if one used salt water lakes for such a trial it eliminates this risk.

- *Eric Wartenweiler Smith* on March 24, 2012 6:36 pm

  But what if, instead of giant prairies that consume vast areas of the ocean, we just build smaller floating islands capable of sustaining aquaculture, bio-remediation as described, and a platform for straining out plastics and re-cycling them into a bio-mimetic material such as Bruce Kania’s Bio-Haven? It could be a step forward for solving several oceanic pollution issues.

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