Population Geography Course, by W. W. Munroe (2010)

Chapter 4 - Life

Main points: life, anerobic bacteria, chlorophil, oxygen waste, aerobic bacteria.

Main Sources: Gaia Hypothesis; wikipedia – Notes from The Nature of Things.

Earth provides ingredients, as well as conditions (eg distance to the sun) for life.

Earth is made up of 3 main parts each with subsets; they are the lithosphere, biosphere and the atmosphere.

Oceans provide a Primordial soup with the right chemicals to create life.

> Morse and MacKenzie have suggested that oceans may have appeared first in the Hadean eon, as soon as two hundred million years (200 Ma) after the Earth was formed, in a hot 100 °C (212 °F) reducing environment, and that the pH of about 5.8 rose rapidly towards neutral.[19] This has been supported by Wilde[2] who has pushed the date of the zircon crystals found in the metamorphosed quartzite of Mount Narryer in Western Australia, previously thought to be 4.1–4.2 Ga, to 4.404 Ga. This means that oceans and continental crust existed within 150 Ma of Earth's formation. http://en.wikipedia.org/wiki/Abiogenesis

Mineralization – Chemicals – Lightening - First life - Amino acids - Abiogenesis

> In the natural sciences, abiogenesis or biopoesis is the theory of how life on Earth could have arisen from inanimate matter.
>
> It should not be confused with evolution, which is the study of how groups of already living things change over time, or with cosmogony, which covers how the universe might have arisen. Most amino acids, often called "the building blocks of life", can form via natural chemical reactions unrelated to life, as demonstrated in the Miller–Urey experiment and similar experiments, which involved simulating the conditions of the early Earth, in a scientific laboratory. In all living things, these amino acids are organized into proteins, and the construction of these proteins is mediated by nucleic acids. Which of these organic molecules first arose and how they formed the first life is the focus of abiogenesis.
>
> http://en.wikipedia.org/wiki/Abiogenesis

Oceans

- First life
  - Amino acids, Sugars – life is sweet
  - Deep sea vents – baceria are rock eaters - Harsh environments –
  - Anerobic bacteria – blue green algea, stromatolites, why are they alive?
  - Chlorophyl, by product – oxygen as waste

Oxygen slowly enters biosphere

Estimated evolution of atmospheric P_{O_2}. The upper red and lower green lines represent the range of the estimates. The stages are: stage 1 (3.85–2.45Gyr ago (Ga)), stage 2 (2.45–1.85Ga), stage 3 (1.85–0.85Ga), Stage 4 (0.85–0.54Ga)and stage 5 (0.54Ga–present)

http://en.wikipedia.org/wiki/File:Oxygenation-atm.svg

oxygen fixes to everything it can, eventually …

Free Oxygen fills atmosphere

today dead zones appear due to abundance of nitrogen and growth of life followed by rapid decline and oxygen loss due to fixing to carbon and debris

anerobic bacteria should grow releasing more oxygen.

Lynn Margulis - Endosymbiotic theory - anarobic cells moved into other organisms to escape oxygen – were able to survive and able to contribute .

Birth of the Ocean by Nature of Things - D Suzuki

(Notes from the series)

The Ocean is critical to life

Beginnings

4.5 billion ya

Erta allie

Earth gathering material from space becoming a giant ball of red hot magma. Earth was a planet of lava. Gases were able to fill an atmosphere including H_2O. Water was squeed out of the center of the earth to the surface, where it entered the atmosphere as gas, only to be rained back down cooling the surface.

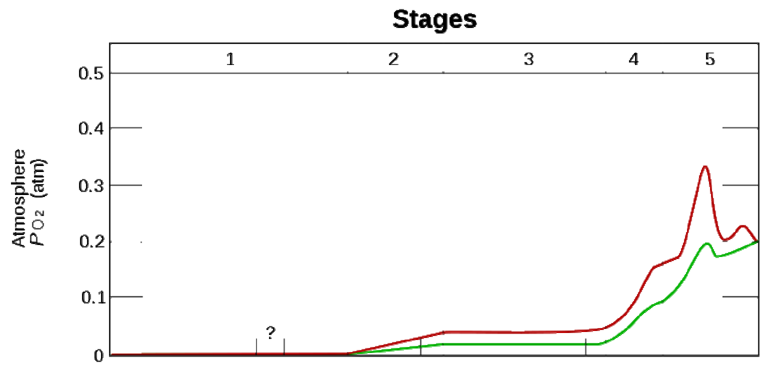
The role of the Oceans in creating and sustaining life.

½ the oxygen comes from the ocean which uses ½ the CO2. Ocean regulates the temperature.

Stromatalites - Peter Ward Paleontologist U of Washington.

Shark Bay Australia, one single cell 3.5 b ya to .5 bya. Builds layer upon layer, sticky bacteria. sand sticks to the bacteria bilding it up to rock like apperance creating stromatalites. They once covered the ocean floors, gone now, but the fossils are every where. They suffered one of the worst mass extinctions. What forces wiped them out?

The atmosphere was oxygen free



Ocean filled with anarobic bacteria

single cells gain energy from the rocks. Eventually, solar power was tapped. Pigment cells to harnass the suns energy, chlorophorm photosynthesis gave out oxygen biproduct as waste, accululated in oceans and atmosphere, oxygen gave life.

Created organizms that grazed on the stromatolites eating them. life started in the ocean new species still being found.

Black smokers plumes - Tunicliff UoV. Hydrothermal vents - Juan de fuca ridge, Black smokers plumes, Hot, Posionous gas, Heavy metals – gold,. Lots of life Water moves through cracks, Boils back up, Build chimney like structures. Surrounding them are Tube worms One bacteria feeds on Chemosynthesis which in turn supports other organisms including animals.

Anarobic bacteria, eat the heavy metals, Hardy microbes attract wide variety of creatures Crabs eat bacteria off arms Tube worms no mouth or gut Inserted bacteria into worm wear they are trapped inside. Given a chance life can make the most of almost any setting. Given the slightest chance life can take advantage of it. Given more favourable conditions life can explode 600 mi ya multi celluar organisms started to take over the ocean

Coral and sponge reefs homes for many animals, Teaming with variety of life. 400 mil yrs - exposed to the sun – devonian reefs in Australia, 400 mil yrs Barrier reefs built up around coasts Biodiversity Coral to animals to microbes, Microbes took over

Oceans gets oxygen from waves

Conveyers in oceans with differences in temperatures
Heat can shut down conveyers
Reefs died
Hydrogen sulfide
Microbe breaks down sulfur
Bubbles rise to the atmosphere
Poisons air kills plants and animals

Purple ocean green skies
Caused all extinctions
Environmental conditions very narrow
Temp, acidity, salt in the water slight variation and we die
Microbes can take temp more acid, salt
Microbes can adapt more easily
Microbes will be the last life on earth
Which creatures have survived mass extinctions
Living fossils able to survive preditors changes in the ocean
Some survive mass extinction
Evolution gets it supremly right – do not have to change anything
Why do some die and some live

The nautalis

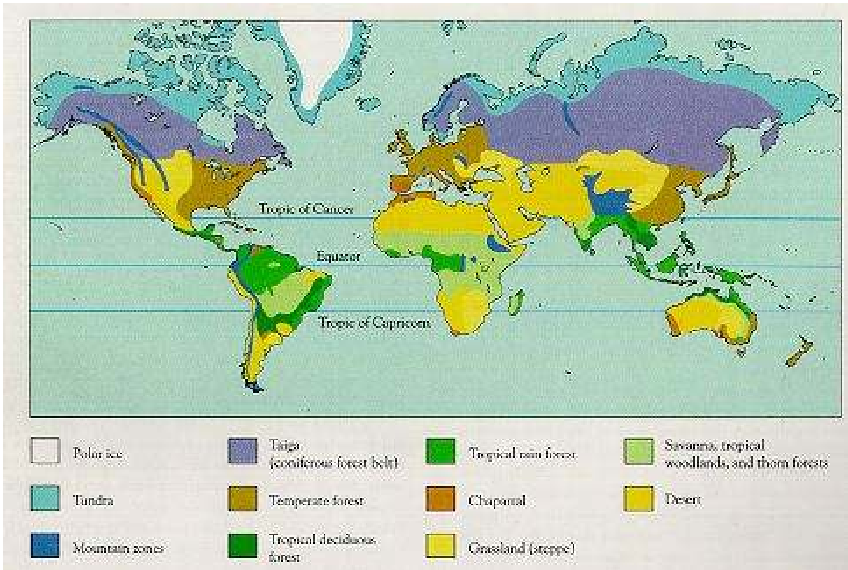
500 million years
Australia osprey reef
Andy dunstan
Trapping nuatalis
Nocternal – Can't see
Tentacles
Top preditor 500 million years ago
Swim and swoop down on Trilobites to eat the crew
Sharks can survive low oxygen
No bone
Strong and light
will eat anything
Will eat other sharks
Other creatures took over and pushed down the nautalis to depths deep enough to survive
Got thru bacteria and comet extinctions
We maybe in a 6th extinction
2 trillion metric tonnes of carbon into the atmosphere
http://oneocean.cbc.ca/series/episodes/1-birth-of-an-ocean

Footprints by Nature of Things - D Suzuki - Notes from the series

2 billion people on the coast estimated
2030 all coast will be developed (?)
Mediterean
- Bluefin numbers decline
- Nile Delta
- Lagoons
- Vegetation cover
- Like a lung for cleaning air
- Conserve life
- Explosion in fish population
- Increase human pop
- Industry and agriculture

- Coastal sprawl
  - Wet lands cut off by development
  - Choked
  - Oxygen levels down
  - Sewage and fertilizers – dangers
  - dumping
  - oxygen needed for sea life
  - smothered by over pop and pollution
  - marine deserts
- gulf of mexico
  - death zone
  - no life at all
  - only the pelican
  - human caused dead zones
  - oxygen content depleted below level to support life hypoxia
  - spring rain – agriculture – fertilizers make..
  - bacteria blooms
  - take oxygen when bacteria die
  - hydrogen sulfide
  - 1970's
  - 22,000 sq km
  - Missippi to texas
  - 1985 annual tests begin
  - Aperiodic to consistant
  - Doubled every ten years
  - Baltic sea dead zone
  - Wet lands removed
  - 90% of marine life need wet lands at some point in their life
  - Protect land
  - Refuge for sea life
  - Coral reefs
  - Among the oldest living communittes on earth
  - zanzibar
  - same fish pop – increased humans = fewer fish per fisher
  - marine reserves
- New Zealand
  - 7 years for life to rebound
  - Some take reduced numbers
  - No take – no take is the only way to get significant results
  - Protects 30% of land
  - 32 marine reserved

Biosphere



The planet's life forms are sometimes said to form a "biosphere". This biosphere is generally believed to have begun evolving about 3.5 billion years ago. Earth is the only place in the universe where life is known to exist. Some scientists believe that Earth-like biospheres might be rare.[132]

The biosphere is divided into a number of biomes, inhabited by broadly similar plants and animals. On land primarily latitude and height above the sea level separates biomes. Terrestrial biomes lying within the Arctic, Antarctic Circle or in high altitudes are relatively barren of plant and animal life, while the greatest latitudinal diversity of species is found at the Equator.[133]

What is a Biome?

A biome is a large geographical area of distinctive plant and animal groups, which are adapted to that particular environment. The climate and geography of a region determines what type of biome can exist in that region. Major biomes include deserts, forests, grasslands, tundra, and several types of aquatic environments. Each biome consists of many ecosystems whose communities have adapted to the small differences in climate and the environment inside the biome.

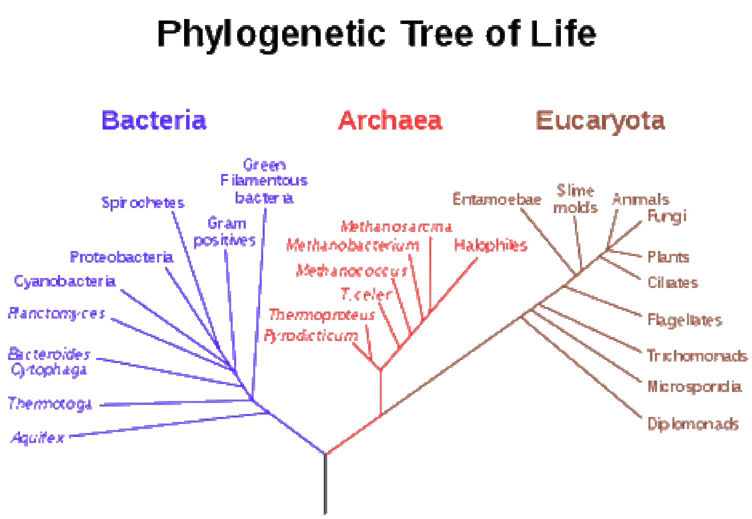
All living things are closely related to their environment. Any change in one part of an environment, like an increase or decrease of a species of animal or plant, causes a ripple effect of change in through other parts of the environment.

The earth includes a huge variety of living things, from complex plants and animals to very simple, one-celled organisms. But large or small, simple or complex, no organism lives alone. Each depends in some way on other living and nonliving things in its surroundings.

http://www.google.com/imgres?imgurl=http://www.sbschools.org/schools/bc/med iacenter/images/world_biomes_map.gif&imgrefurl=http://www.sbschools.org/schools/bc/mediacenter/biomes.php&h=421&w=658&sz=19&tbnid=bATbu04W5Hcc3M:&tbnh=88&tbnw=138&prev=/images%3Fq%3Dbiomes%2Bof%2Bthe%2Bworld&hl=en&usg=__0wXyEhRLj5ht-wiwwBrnbki4HQ8=&ei=TM6oS5vaN4KYsgPBq_muAg&sa=X&oi=image_result&resnum=5&ct=image&ved=0CBYQ9QEwBA

Evolutionary tree or phylogenetic tree or

A phylogenetic tree or evolutionary tree is a branching diagram or "tree" showing the inferred evolutionary relationships among various biological species or other entities based upon similarities and differences in their physical and/or genetic characteristics. The taxa joined together in the tree are implied to have descended from a common ancestor. In a rooted phylogenetic tree, each node with descendants represents the inferred most recent common ancestor of the descendants, and the edge lengths in some trees may be interpreted as time estimates. Each node is called a taxonomic unit. Internal nodes are generally called hypothetical taxonomic units (HTUs) as they cannot be directly observed.



Synapsids

Synapsids ('fused arch'), also known as theropsids ('beast face'), are a class of animals that includes mammals and everything closer to mammals than to other living amniotes.[1] The non-mammalian members are described as mammal-like reptiles in classical systematics,[2][3] but are referred to as "stem-mammals" or "proto-mammals" under cladistic terminology.[4] Synapsids evolved from basal amniotes and are one of the two major groups of the later amniotes, the other major group being the sauropsids (reptiles and birds). They are distinguished from other amniotes by having a single opening (temporal fenestra) in their skull behind each eye, which developed in the ancestral synapsid about 324 million years ago (mya) during the late Carboniferous Period.

Synapsids were the dominant terrestrial animals in the middle to late Permian period. As with almost all life forms then extant, their numbers and variety were severely reduced by the Permian extinction. Some species survived into the Triassic period, but archosaurs quickly became the dominant animals and few of the non-mammalian synapsids outlasted the Triassic, although survivors persisted into the Cretaceous. However, they included the prehistoric ancestors of mammals and in this sense, synapsids are still very much a living class of vertebrates.

http://www.tellapallet.com/tree_of_life.htm

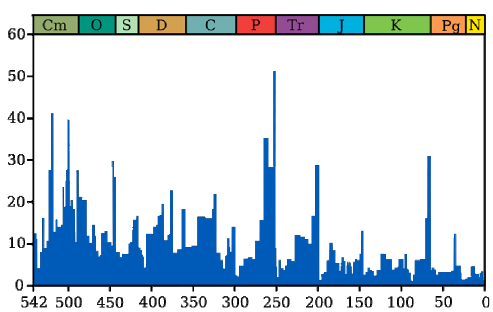
The last universal ancestor

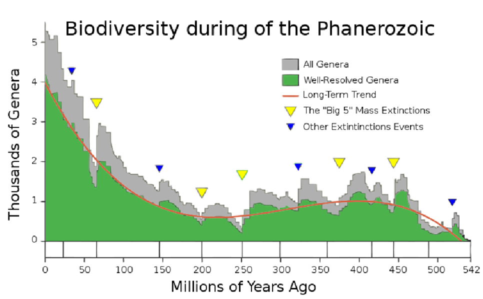
The last universal ancestor (LUA), also called the last universal common ancestor (LUCA), or the cenancestor, is the most recent organism from which all organisms now living on Earth descend. Thus it is the most recent common ancestor (MRCA) of all current life on Earth. The LUA is estimated to have lived some 3.5 to 3.8 billion years ago (sometime in the Paleoarchean era).[1][2]

http://en.wikipedia.org/wiki/Last_universal_common_ancestor

Mass Extinctions since the Camberian explosion about 500 Ma to about 570 Ma.

The classical "Big Five" mass extinctions identified by Jack Sepkoski and David M. Raup in their 1982 paper are widely agreed upon as some of the most significant: End Ordovician, Late Devonian, End Permian, End Triassic, and End Cretaceous.[2][3]





Cretaceous–Tertiary extinction event (K-T extinction) - 65 Ma ago at the Cretaceous-

Paleogene transition.

meteor

About 17% of all families, 50% of all genera and 75% of species went extinct.[4] It ended the reign of dinosaurs and opened the way for mammals and birds to become the dominant land vertebrates. In the seas it reduced the percentage of sessile animals to about 33%. The K-T extinction was rather uneven — some groups of organisms became extinct, some suffered heavy losses and some appear to have been only minimally affected.

Triassic–Jurassic extinction event - 205 Ma at the Triassic-Jurassic transition.

PosibilyMassive volcanic eruptions, specifically the flood basalts of the Central Atlantic Magmatic Province, would release carbon dioxide or sulfur dioxide which would cause either intense global warming (from the former) or cooling (from the latter).

This event happened in less than 10,000 years and occurred just before Pangaea started to break apart.

About 23% of all families and 48% of all genera (20% of marine families and 55% of marine genera) went extinct.[4] Most non-dinosaurian archosaurs, most therapsids, and most of the large amphibians were eliminated, leaving dinosaurs with little terrestrial competition. Non-dinosaurian archosaurs continued to dominate aquatic environments, while non-archosaurian diapsids continued to dominate marine environments. The Temnospondyl lineage of large amphibians also survived until the Cretaceous in Australia (e.g., Koolasuchus).

Permian–Triassic extinction event - 251 Ma at the Permian-Triassic transition. The great dying

Oxygen depletion

Earth's largest extinction killed 57% of all families and 83% of all genera (53% of marine families, 84% of marine genera, about 96% of all marine species and an estimated 70% of land species) including vertebrates, insects and plants.[4] The "Great Dying" had enormous evolutionary significance: on land, it ended the primacy of mammal-like reptiles. The recovery of vertebrates took 30 million years,[5] but the vacant niches created the opportunity for archosaurs to become ascendant. In the seas, the percentage of animals that were sessile dropped from 67% to 50%. The whole late Permian was a difficult time for at least marine life, even before the "Great Dying".

Late Devonian extinction 360-375 Ma near the Devonian-Carboniferous transition.

Anarobitc bacteria
CO_2 levels up
At the end of the Frasnian Age in the later part(s) of the Devonian Period, a prolonged series of extinctions eliminated about 19% of all families, 50% of all genera and 70% of all species.[4] This extinction event lasted perhaps as long as 20 MY, and there is evidence for a series of extinction pulses within this period.

Ordovician–Silurian extinction event 440-450 Ma at the Ordovician-Silurian transition.

triggered by the onset of a long ice age,

Two events occurred that killed off 27% of all families and 57% of all genera.[4] Together they are ranked by many scientists as the second largest of the five major extinctions in Earth's history in terms of percentage of genera that went extinct.

http://en.wikipedia.org/wiki/Extinction_event

Holocene extinction

The Holocene extinction is the widespread, ongoing extinction of species during the present Holocene epoch. The large number of extinctions span numerous families of plants and animals including mammals, birds, amphibians, reptiles and arthropods; a sizeable fraction of these extinctions are occurring in the rainforests.

Between 1500 and 2009 CE, 875 extinctions have been documented by the International Union for Conservation of Nature and Natural Resources.[1] However, since most extinctions go undocumented, scientists estimate that during the 20th century, between 20,000 and two million species actually became extinct, but the precise total cannot be determined more accurately within the limits of present knowledge. Up to 140,000 species per year (based on Species-area theory)[2] may be the present rate of extinction based upon upper bound estimating.

http://en.wikipedia.org/wiki/Holocene_extinction

The coral reef crisis: The critical importance of <350 ppm CO_2

Abstract: Temperature-induced mass coral bleaching causing mortality on a wide geographic scale started when atmospheric CO_2 levels exceeded 320 ppm. When CO_2 levels reached 340 ppm, sporadic but highly destructive mass bleaching occurred in most reefs world-wide, often associated with El Niño events. Recovery was dependent on the vulnerability of individual reef areas and on the reef’s previous history and resilience. At today’s level of 387 ppm, allowing a lag-time of 10 years for sea temperatures to respond, most reefs world-wide are committed to an irreversible decline. Mass bleaching will in future become annual, departing from the 4 to 7 years return-time of El Niño events. Bleaching will be exacerbated by the effects of degraded water-quality and increased severe weather events. In addition, the progressive onset of ocean acidification will cause reduction of coral growth and retardation of the growth of high magnesium calcite-secreting coralline algae. If CO_2 levels are allowed to reach 450 ppm (due to occur by 2030–2040 at the current rates), reefs will be in rapid and terminal decline world-wide from multiple synergies arising from mass bleaching, ocean acidification, and other environmental impacts. Damage to shallow reef communities will become extensive with consequent reduction of biodiversity followed by extinctions. Reefs will cease to be large-scale nursery grounds for fish and will cease to have most of their current value to humanity. There will be knock-on effects to ecosystems associated with reefs, and to other pelagic and benthic ecosystems. Should CO_2 levels reach 600 ppm reefs will be eroding geological structures with populations of surviving biota restricted to refuges. Domino effects will follow, affecting many other marine ecosystems. This is likely to have been the path of great mass extinctions of the past, adding to the case that anthropogenic CO_2 emissions could trigger the Earth's sixth mass extinction.

ScienceDirect.com

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6N-4X9NKG7-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1127457283&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=2acbcd59d5927af20393401088e93179#secx2

Palaeocene-Eocene Thermal Maximum - event 55 million years ago

The event saw global temperatures rise by around 6°C (11°F) over 20,000 years, with a corresponding rise in sea level as the whole of the oceans warmed.[2] Atmospheric carbon dioxide (CO_2) concentrations rose, causing a shallowing of the lysocline. Regional deep water anoxia may have played a part in marine extinctions.

http://en.wikipedia.org/wiki/Paleocene-Eocene_Thermal_Maximum

Natural selection

Natural selection is the process by which those heritable traits that make it more likely for an organism to survive and successfully reproduce become more common in a population over successive generations. It is a key mechanism of evolution.

The natural genetic variation within a population of organisms means that some individuals will survive and reproduce more successfully than others in their current environment. For example, the peppered moth exists in both light and dark colors in the United Kingdom, but during the industrial revolution many of the trees on which the moths rested became blackened by soot, giving the dark-colored moths an advantage in hiding from predators. This gave dark-colored moths a better chance of surviving to produce dark-colored offspring, and in just a few generations the majority of the moths were dark. Factors which affect reproductive success are also important, an issue which Charles Darwin developed in his ideas on sexual selection.

http://en.wikipedia.org/wiki/Natural_selection

Gaia Hypothesis and feedback loops,

Interview with James Lovelock on Global Warming

Your work on atmospheric chlorofluorocarbons led eventually to a global CFC ban that saved us from ozone-layer depletion. Do we have time to do a similar thing with carbon emissions to save ourselves from climate change?

Is Carbon Trading working?

Not a hope in hell. Most of the "green" stuff is verging on a gigantic scam. Carbon trading, with its huge government subsidies, is just what finance and industry wanted. It's not going to do a damn thing about climate change, but it'll make a lot of money for a lot of people and postpone the moment of reckoning. I am not against renewable energy, but to spoil all the decent countryside in the UK with wind farms is driving me mad. It's absolutely unnecessary, and it takes 2500 square kilometres to produce a gigawatt - that's an awful lot of countryside.

James Lovelock

What about work to sequester carbon dioxide?

That is a waste of time. It's a crazy idea - and dangerous. It would take so long and use so much energy that it will not be done.

Do you still advocate nuclear power as a solution to climate change?

It is a way for the UK to solve its energy problems, but it is not a global cure for climate change. It is too late for emissions reduction measures.

So are we doomed?

There is one way we could save ourselves and that is through the massive burial of charcoal. It would mean farmers turning all their agricultural waste - which contains carbon that the plants have spent the summer sequestering - into non-biodegradable charcoal, and burying it in the soil. Then you can start shifting really hefty quantities of carbon out of the system and pull the CO_2 down quite fast.

Would it make enough of a difference?

Yes. The biosphere pumps out 550 gigatonnes of carbon yearly; we put in only 30 gigatonnes. Ninety-nine per cent of the carbon that is fixed by plants is released back into the atmosphere within a year or so by consumers like bacteria, nematodes and worms. What we can do is cheat those consumers by getting farmers to burn their crop waste at very low oxygen levels to turn it into charcoal, which the farmer then ploughs into the field. A little CO_2 is released but the bulk of it gets converted to carbon. You get a few per cent of biofuel as a by-product of the combustion process, which the farmer can sell. This scheme would need no subsidy: the farmer would make a profit. This is the one thing we can do that will make a difference, but I bet they won't do it.

Do you think we will survive?

I'm an optimistic pessimist. I think it's wrong to assume we'll survive 2 °C of warming: there are already too many people on Earth. At 4 °C we could not survive with even one-tenth of our current population. The reason is we would not find enough food, unless we synthesised it. Because of this, the cull during this century is going to be huge, up to 90 per cent. The number of people remaining at the end of the century will probably be a billion or less. It has happened before: between the ice ages there were bottlenecks when there were only 2000 people left. It's happening again.

I don't think humans react fast enough or are clever enough to handle what's coming up. Kyoto was 11 years ago. Virtually nothing's been done except endless talk and meetings.

I don't think we can react fast enough or are clever enough to handle what's coming up

It's a depressing outlook.

Not necessarily. I don't think 9 billion is better than 1 billion. I see humans as rather like the first photosynthesisers, which when they first appeared on the planet caused enormous damage by releasing oxygen - a nasty, poisonous gas. It took a long time, but it turned out in the end to be of enormous benefit. I look on humans in much the same light. For the first time in its 3.5 billion years of existence, the planet has an intelligent, communicating species that can consider the whole system and even do things about it. They are not yet bright enough, they have still to evolve quite a way, but they could become a very positive contributor to planetary welfare.

How much biodiversity will be left after this climatic apocalypse?

We have the example of the Palaeocene-Eocene Thermal Maximum event 55 million years ago. About the same amount of CO_2 was put into the atmosphere as we are putting in and temperatures rocketed by about 5 °C over about 20,000 years. The world became largely desert. The polar regions were tropical and most life on the planet had the time to move north and survive. When the planet cooled they moved back again. So there doesn't have to be a massive extinction. It's already moving: if you live in the countryside as I do you can see the changes, even in the UK.

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6N-4X9NKG7-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1127457283&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=2acbcd59d5927af20393401088e93179#secx2

http://en.wikipedia.org/wiki/File:Auto-and_heterotrophs.png

Biotic growth

Babies have babies

Environmental Resistance

Hunts for carrying capacity