

Science Times - Tuesday, September 28, 2004

### DNA Bar Coding Unveils Secrets of Costa Rican Butterfly

By NICHOLE WASE

In one of the first uses of DNA bar coding, a technique that allows scientists to identify species from a single gene, researchers have discovered that the butterfly *Gnathochorax dardanus* is not a single species but is actually composed of at least 10 different species.

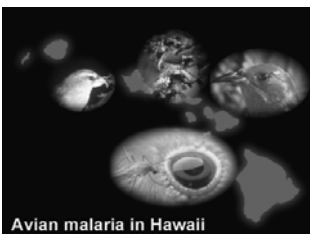
The butterfly, a member of the Pieridae family, has been found in the mountains of Costa Rica. It has a distinctive black and white pattern on its wings. The researchers used DNA bar coding to identify the species. The technique involves sequencing a short, standardized region of the DNA genome, known as a barcode, and comparing it to a reference database. This method is particularly useful for identifying species that are difficult to distinguish based on morphology alone.

The researchers found that the butterfly population in Costa Rica is composed of at least 10 different species. This discovery is significant because it shows that what was previously considered a single species is actually a complex of many different species. This has implications for conservation efforts, as each species may have different requirements and vulnerabilities.



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### Extinction by Infectious Disease



Avian malaria in Hawaii


Because of the introduction of *Culex pipiens* and *Plasmodium gallinaceum* (bird malaria), 5 genera of birds are now extinct.

The introduction of the mosquito *Culex pipiens* and the parasite *Plasmodium gallinaceum* to Hawaii led to the extinction of five genera of birds. This is a classic example of biological invasions causing extinctions. The parasite, which is transmitted by the mosquito, is highly lethal to native bird species that have no natural immunity to it.

### Long Term Ecological Research Network

The International Long Term Ecological Research Network

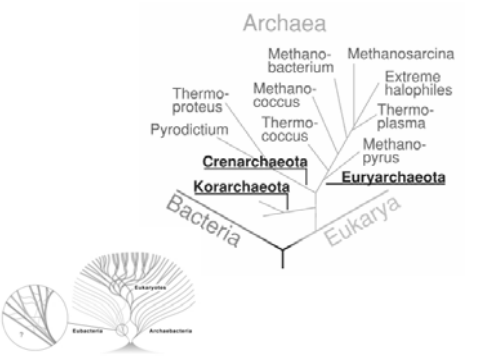
- East Asia Pacific Regional LTER Network
  - Australia
  - China
  - China-Taipei
  - Mongolia
  - South Korea
- North American Regional LTER Network
  - Canada
  - Mexico
- Central/Eastern European Regional LTER Network
  - Austria
  - Czech Republic
  - Hungary
  - Latvia
  - Poland
  - Slovak Republic
  - Ukraine
- African Regional LTER Network
  - Mozambique
  - Namibia
  - South Africa
- Middle East Regional LTER Network
  - Israel
- Western European Regional LTER Network
  - France
  - Switzerland
  - United Kingdom
- Central/South American Regional LTER Network
  - Brazil
  - Colombia
  - Venezuela
  - Costa Rica



Official LTER Networks

Emerging/Coordinating LTER Networks

- Argentina, Ireland, Philippines
- Belarus, Italy, Romania
- China, Japan, Slovakia
- Costa Rica, Kenya, Spain
- Ecuador, Lithuania, Sweden
- Estonia, Norway, Tanzania
- India, Portugal, Venezuela
- Indonesia, Peru, Zimbabwe



Archaea

- Methanobacterium
- Methanococcus
- Thermoplasma
- Methanopyrus
- Methanosarcina
- Extreme halophiles

Crenarchaeota

Euryarchaeota

Bacteria


Eukarya

Thermoproteus

Pyrodictium


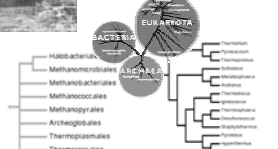
Thermococcus

### Life Without The Sun's Help



This image shows a hydrothermal vent, also known as a black smoker. These vents are found on the seafloor and are characterized by their dark, mineral-rich structures and the plume of superheated water they emit. They are important ecosystems that support life through chemosynthesis, where organisms use chemical energy from the vents instead of sunlight.

### Extremophiles Rule!

Halobacteriales

Methanohalobiales

Methanohalobiales

Methanohalobiales

Methanopyrales

Archaeoglobales

Thermoplasmatales

Thermococcales

www.extremophiles.org



### Tube Worms: not just another pretty face!

PCR depends upon Taq polymerase

*Biogeochemical Cycles:*

- Oxygen
- Carbon
- Sulfur
- Nitrogen
- Phosphorous
- Calcium

### The Oxygen Cycle

Brazil's forests produce 40% of the earth's atmospheric oxygen.

### The Oxygen Cycle

Stromatolites are colonies of cyanobacteria. They began charging the Earth's atmosphere with oxygen some 3.5 billion years ago.

Yesterday      Today

### The Oxygen Cycle

Stratospheric Ozone Production

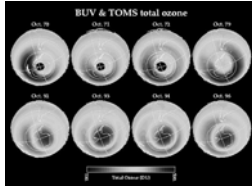
Step 1:  $O_2 + \text{Ultraviolet Sunlight} \rightarrow O + O$

Step 2:  $O + O_2 \rightarrow O_3$

Overall reaction:  $3 O_2 \xrightarrow{\text{sunlight}} 2 O_3$

TOMS  
Total Ozone Monitoring Satellite

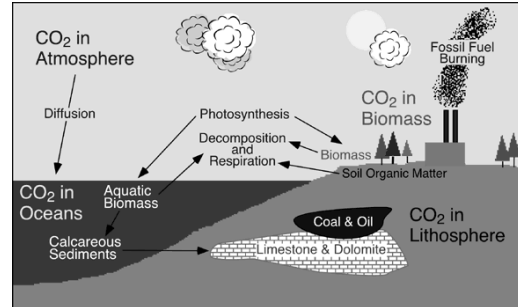
## The Oxygen Cycle



**TOMS**

Depletion of ozone leads to ecosystem health risks.

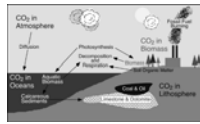
## The Carbon Cycle



## The Carbon Cycle



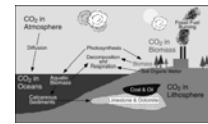
Temperate rainforests store vast amounts of carbon, both above and below ground.



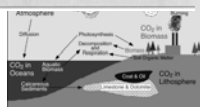
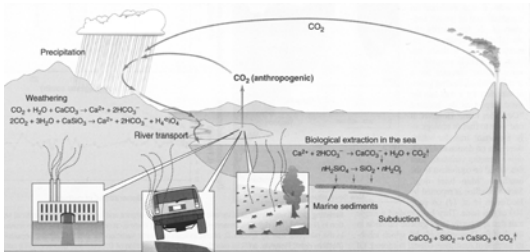
## The Carbon Cycle



Brazil's rainforests re-cycle carbon faster than any other ecosystem.



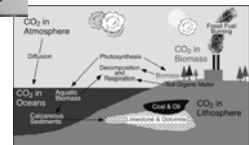
## The Carbon Cycle

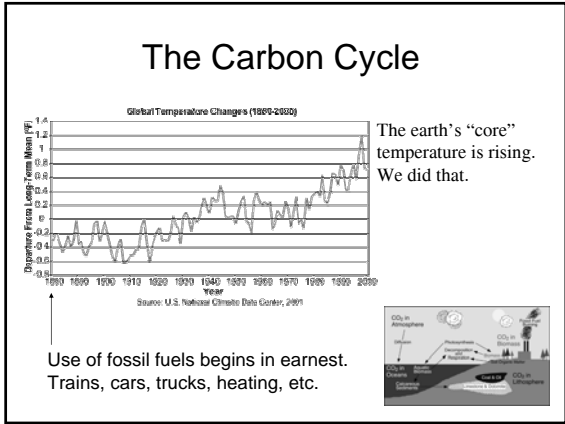
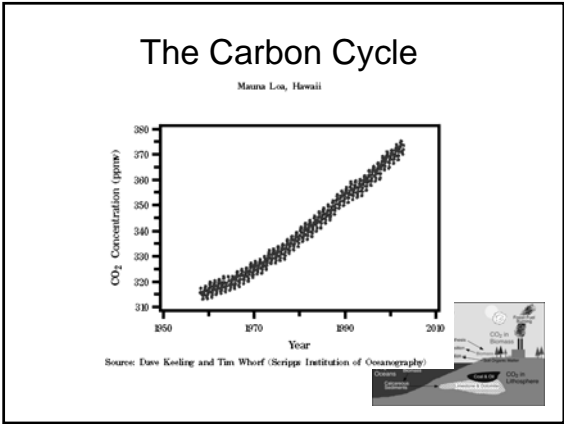


## The Carbon Cycle

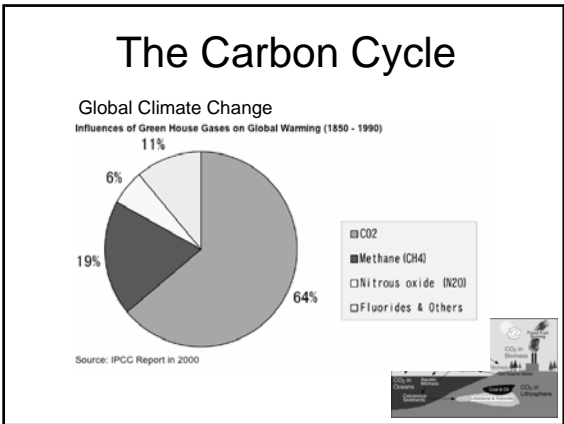
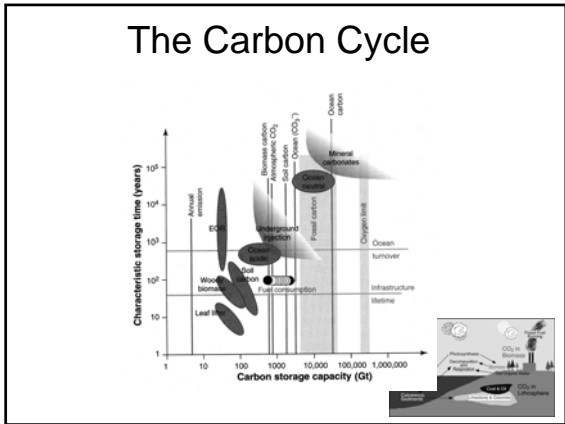


The earth's atmosphere is accumulating CO<sub>2</sub> faster than it can be sequestered.





- ### The Carbon Cycle
- Carbon Sinks:**
1. Marine viruses, bacteria, and phytoplankton
  2. Forests
  3. Coral reefs



### The Carbon Cycle

The Results, So far:

Increase of CO2 % in the Air :

- \* 265 - 285 ppm before the Industrial Revolution (1750 - 1800)
- \* 365 ppm in 1996
- \* Over 600 ppm estimated by the end of 2100

Rising of Sea Levels :

- \* 10 - 25 cm has risen over the past 100 years.
- \* 9 - 86 cm will rise between 1990 - 2100.

Rising of the Earth's Average Temperature :

- \* 0.3 - 0.6 degree Celsius has risen over the past 100 years.
- \* 1.4 - 5.8 degree Celsius will rise between 1990 - 2100.

