Some primary goals of public health are to insure:

1. safe water supplies for all uses.
2. clean air.
3. infectious disease-free and toxin-free food supplies.
4. acceptable housing and a minimum of good medical care for all.

THE NEW YORK TIMES, TUESDAY, SEPTEMBER 2, 2003

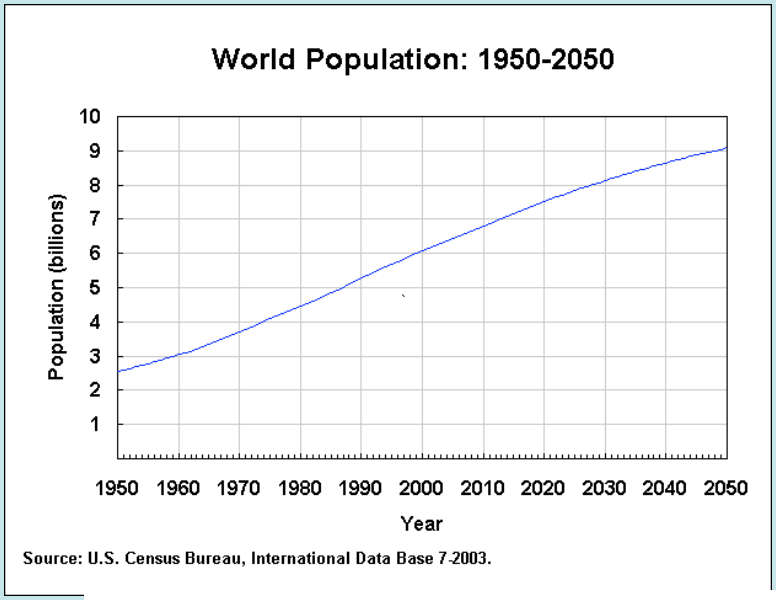
SCIENTIST AT WORK

RICHARD SMALLEY

Small Thoughts for a Global Grid

Kevin Moloney for The New York Times

Dr. Richard E. Smalley, a Nobel laureate famous for his study of carbon nanotubes, has turned his attention to the world's energy needs. In June he spoke at the National Renewable Energy Laboratory in Golden, Colo.



2-3 Billion More People in 50 Years

10^9 hectares is equivalent to the size of Brazil

Forecasting Agriculturally Driven Global Environmental Change

David Tilman,[1]* Joseph Fargione,[1] Brian Wolff,[1]
Carla D'Antonio,[2] Andrew Dobson,[3] Robert Howarth,[4]
David Schindler,[5] William H. Schlesinger,[6] Daniel Simberloff,[7]
Deborah Swackhamer[8]

During the next 50 years, which is likely to be the final period of rapid agricultural expansion, demand for food by a wealthier and 50% larger global population will be a major driver of global environmental change. Should past dependences of the global environmental impacts of agriculture on human population and consumption continue, 10^9 hectares of natural ecosystems would be converted to agriculture by 2050. This would be accompanied by 2.4-

www.sciencemag.org SCIENCE VOL 292 13 APRIL 2001

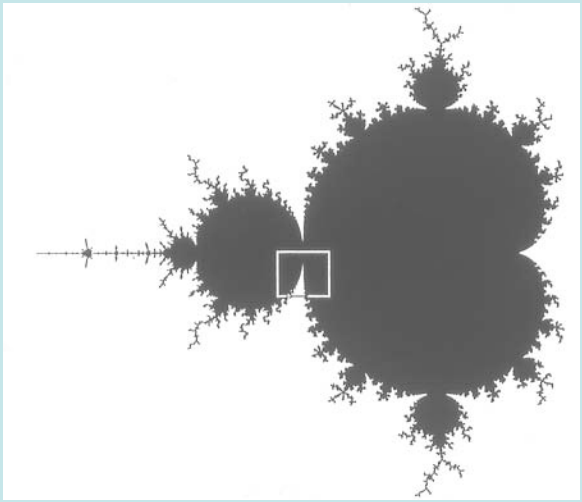
What are the environmental health problems the world will have to face when another 2-3 billion people are added to it?

Who is this man and why is he smiling?

(He's Benoit Mandelbrot)

$$x_{n+1} = f(x_n) = x_n^2 + c$$

The Mandelbrot Set

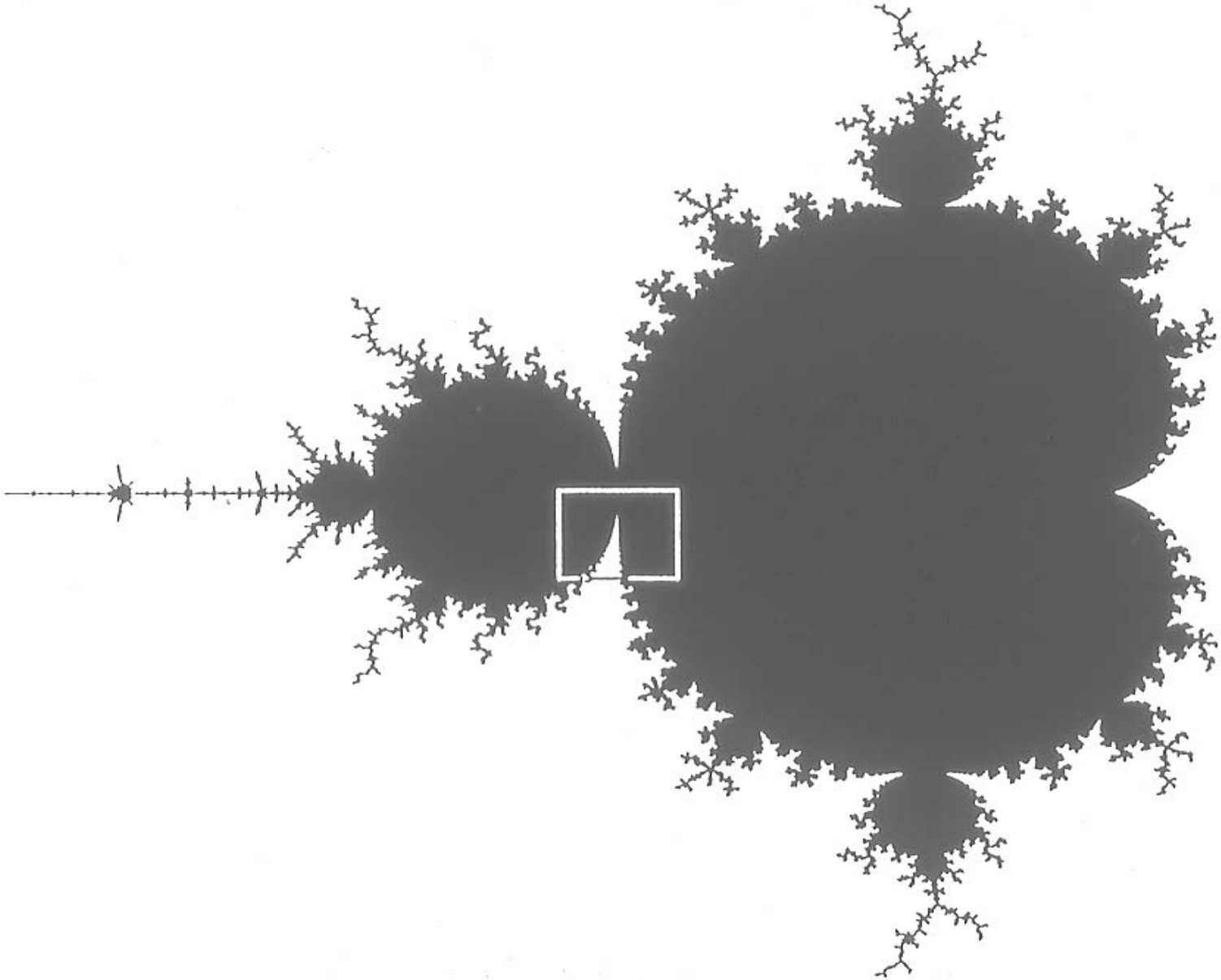


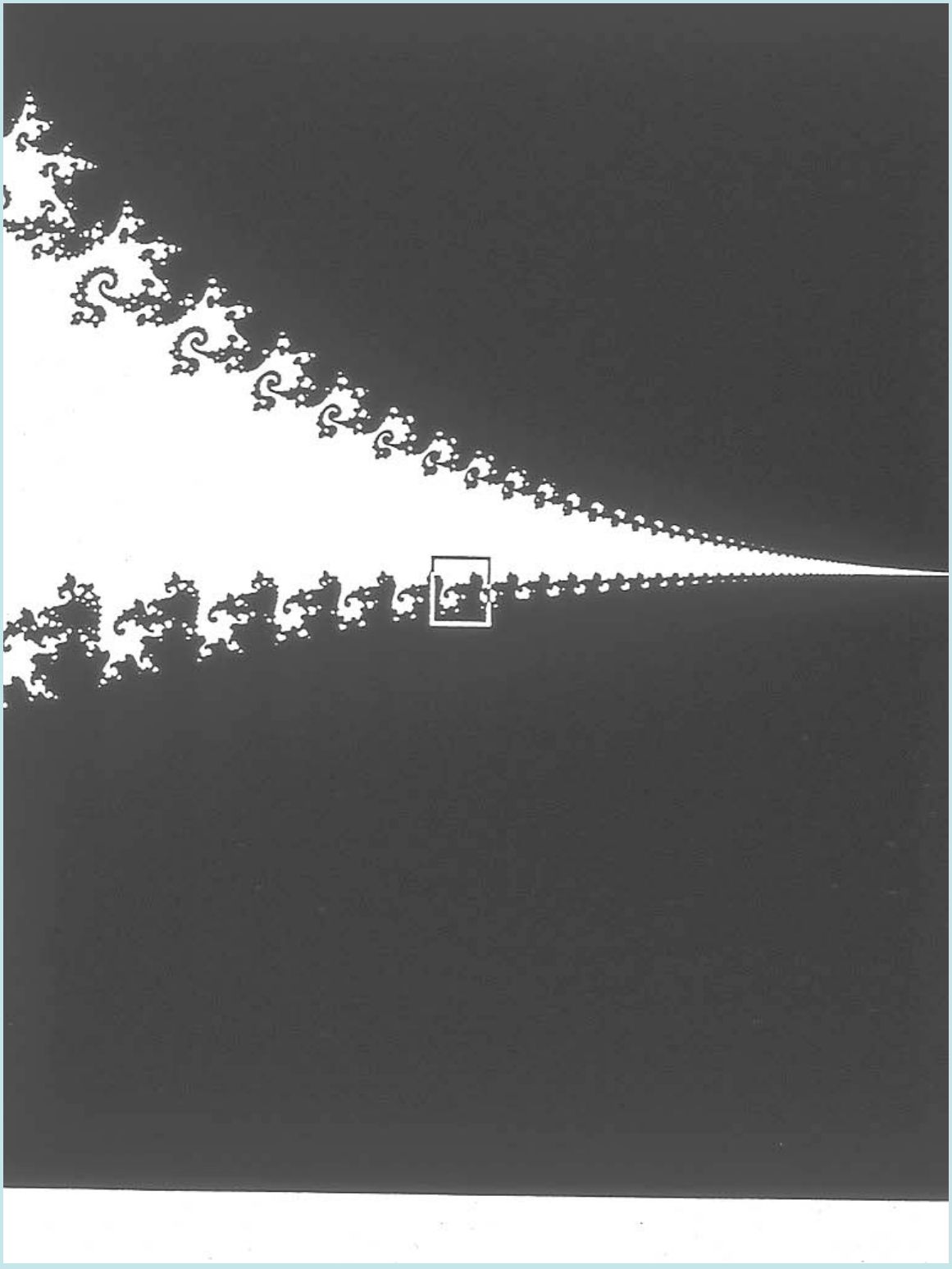
H.-O. Peitgen · P.H. Richter

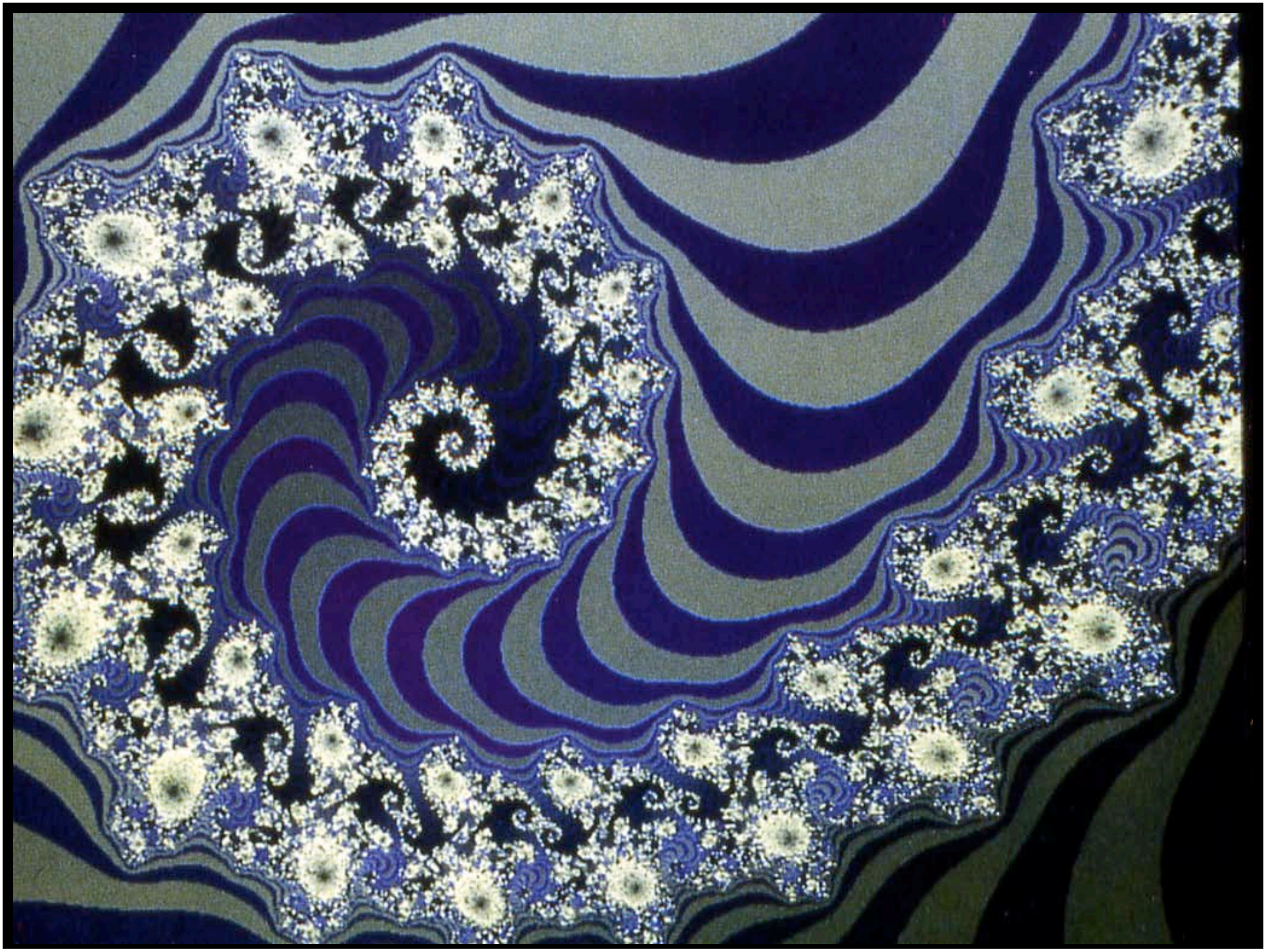
The Beauty of Fractals

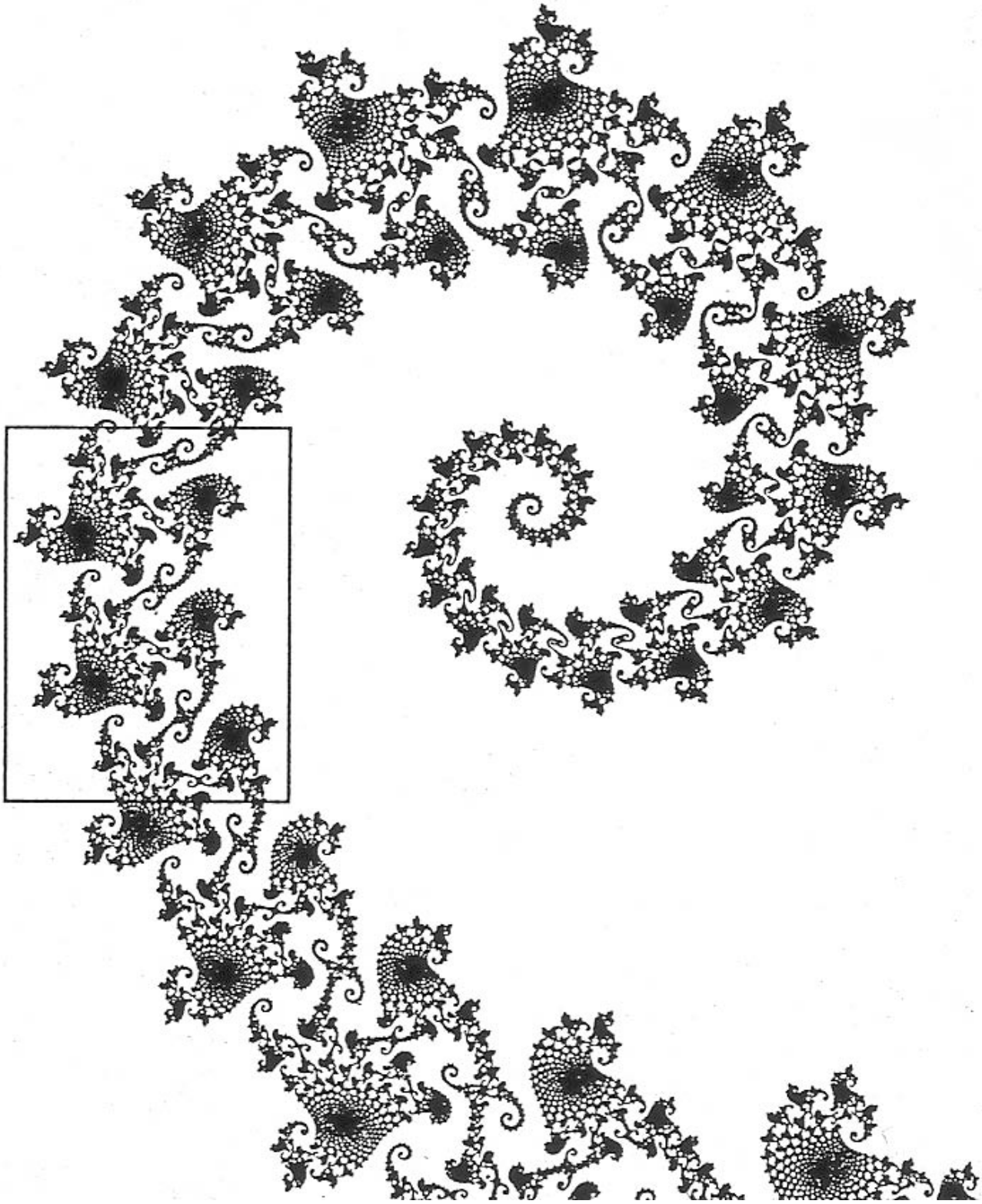
Images of Complex Dynamical Systems

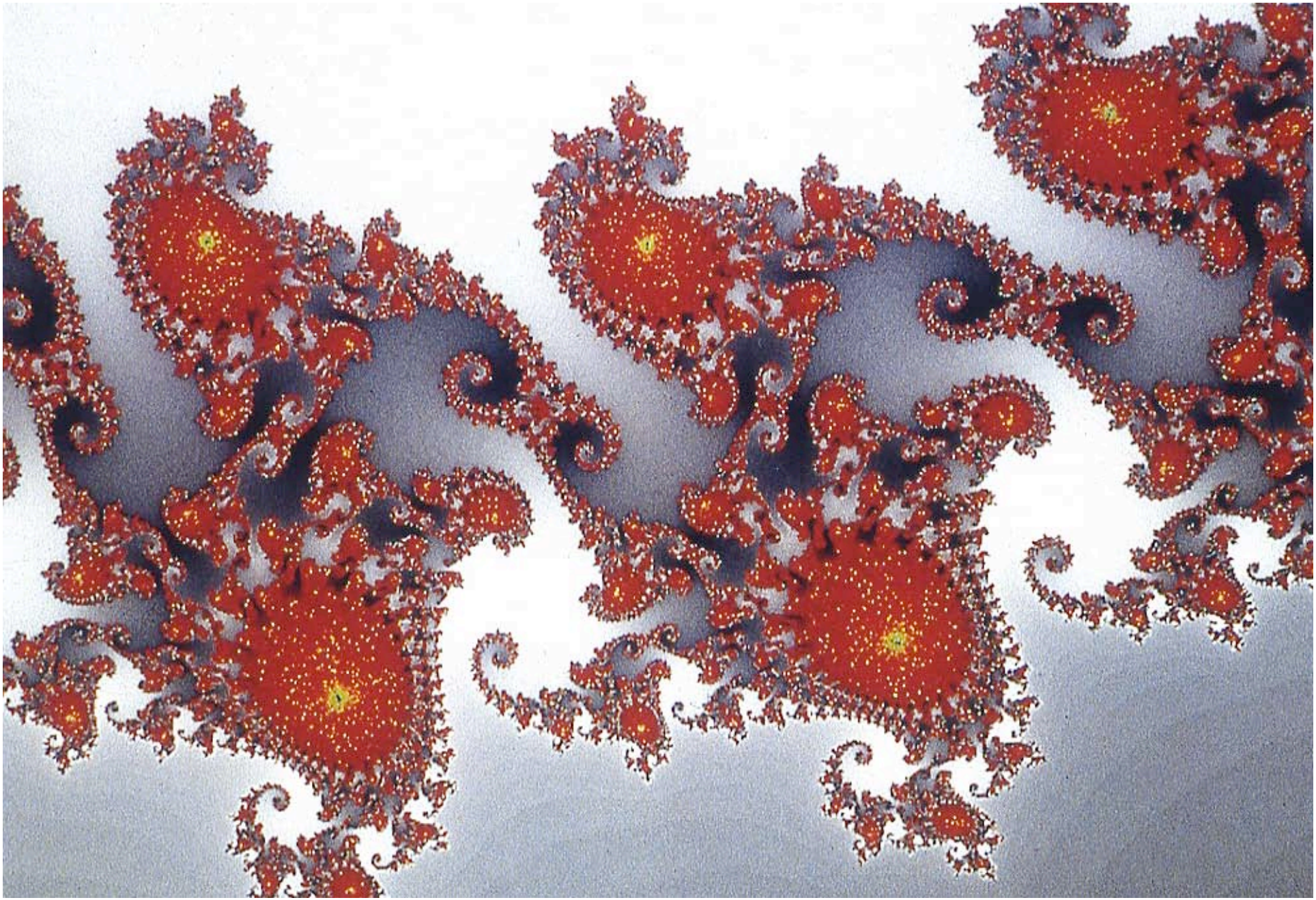
Springer-Verlag Berlin Heidelberg New York Tokyo

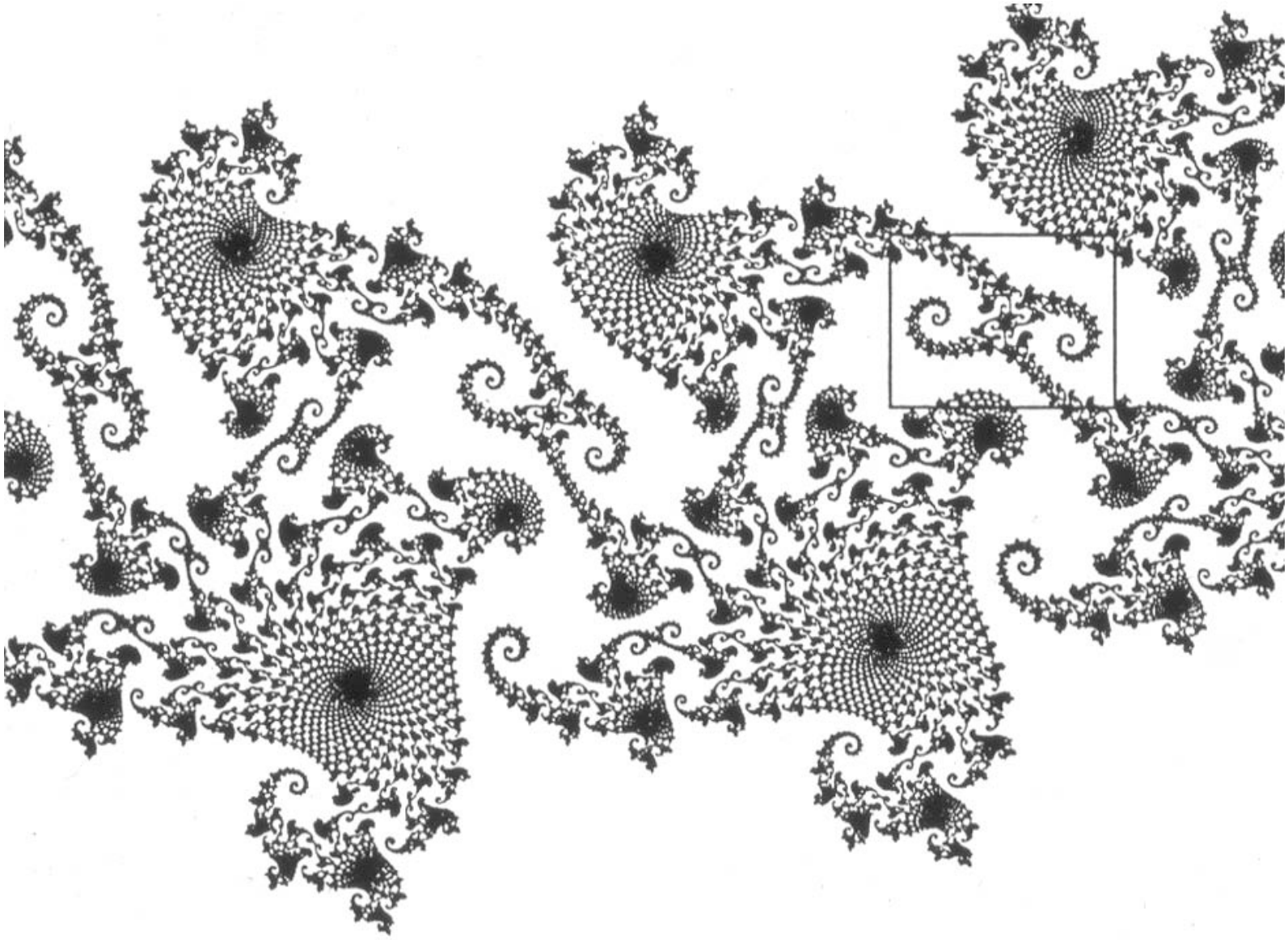












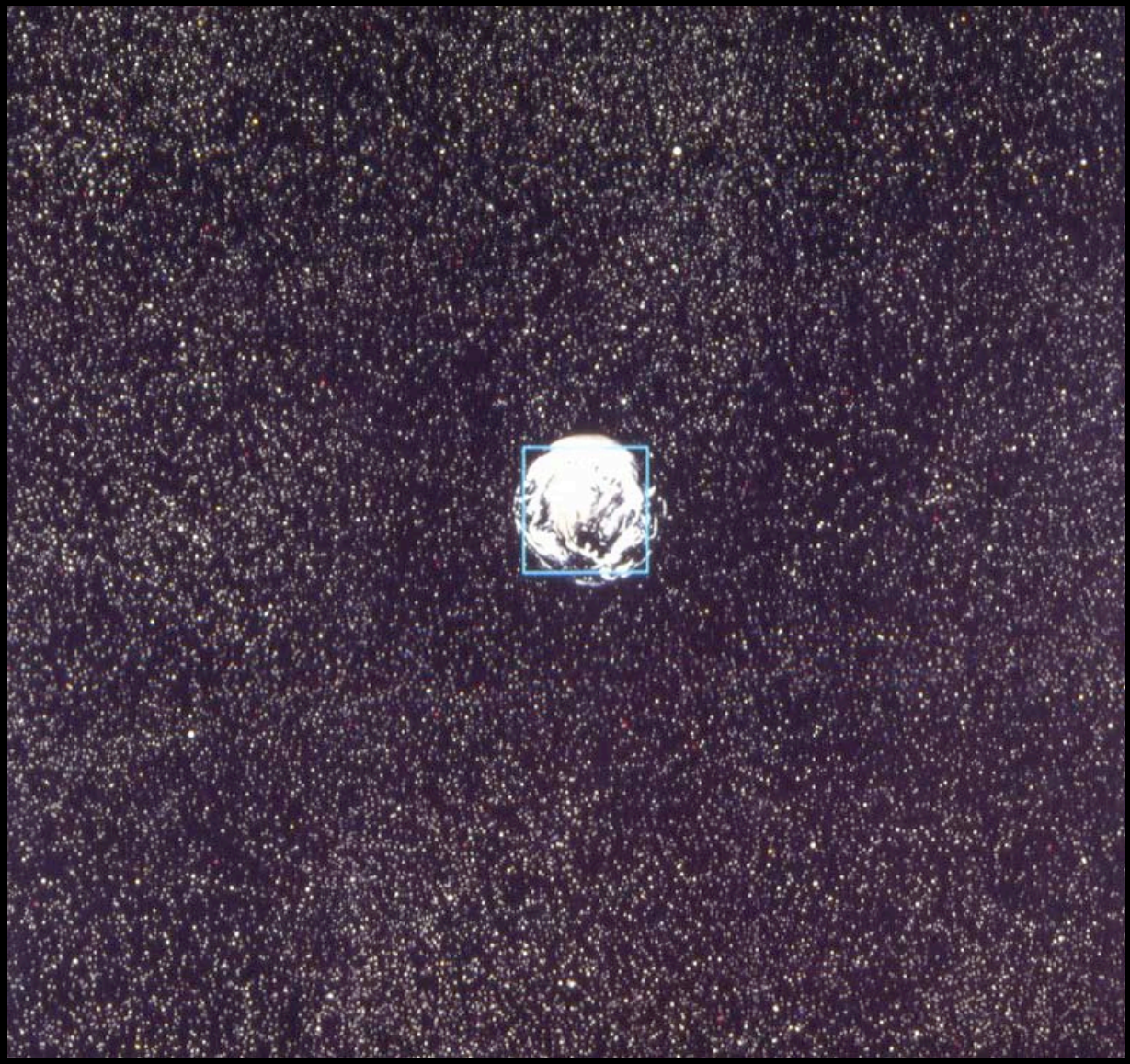
PHILIP MORRISON & PHYLIS MORRISON
and THE OFFICE OF CHARLES & RAY EAMES

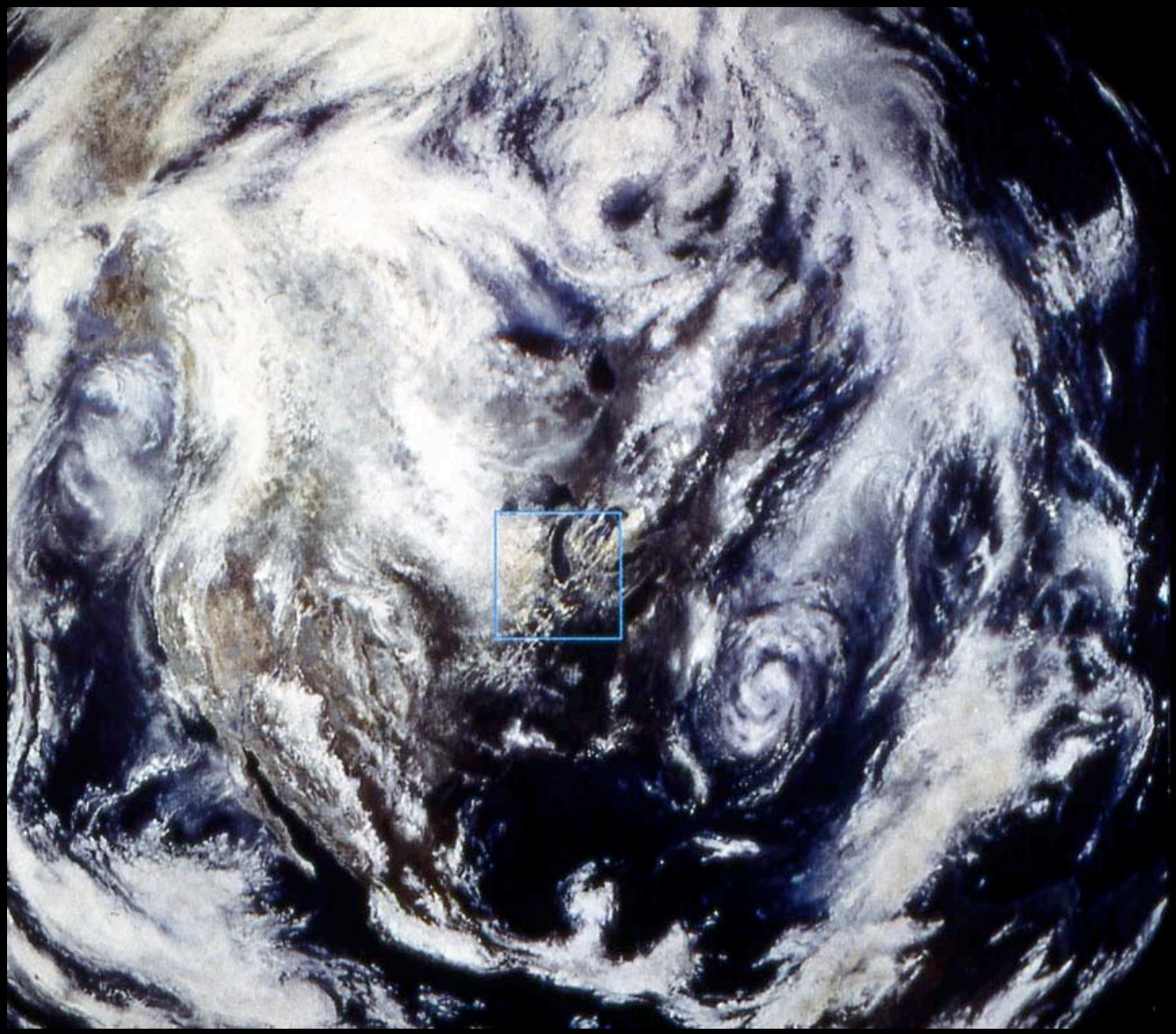
POWERS OF TEN

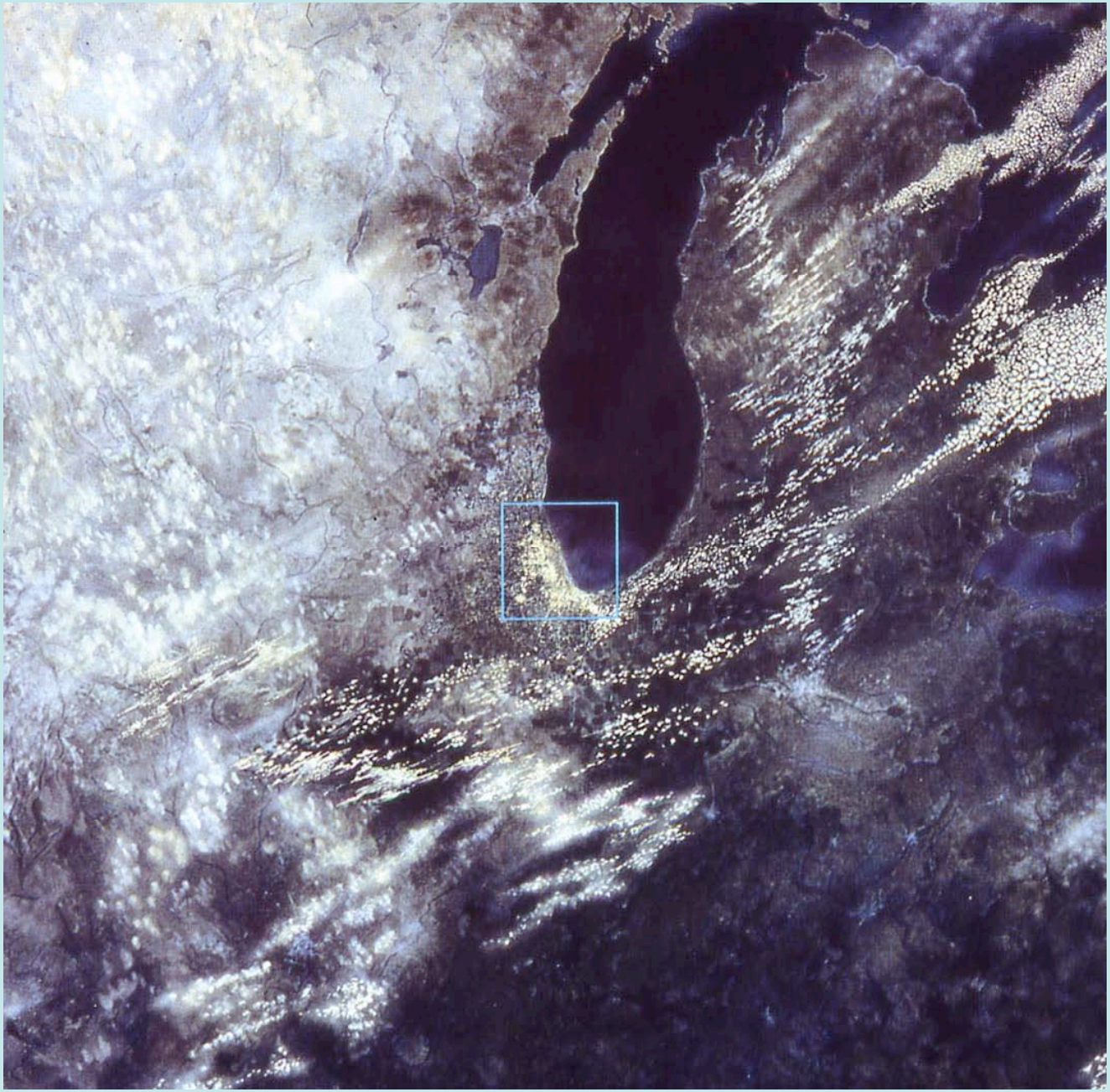
About the Relative Size of Things in the Universe

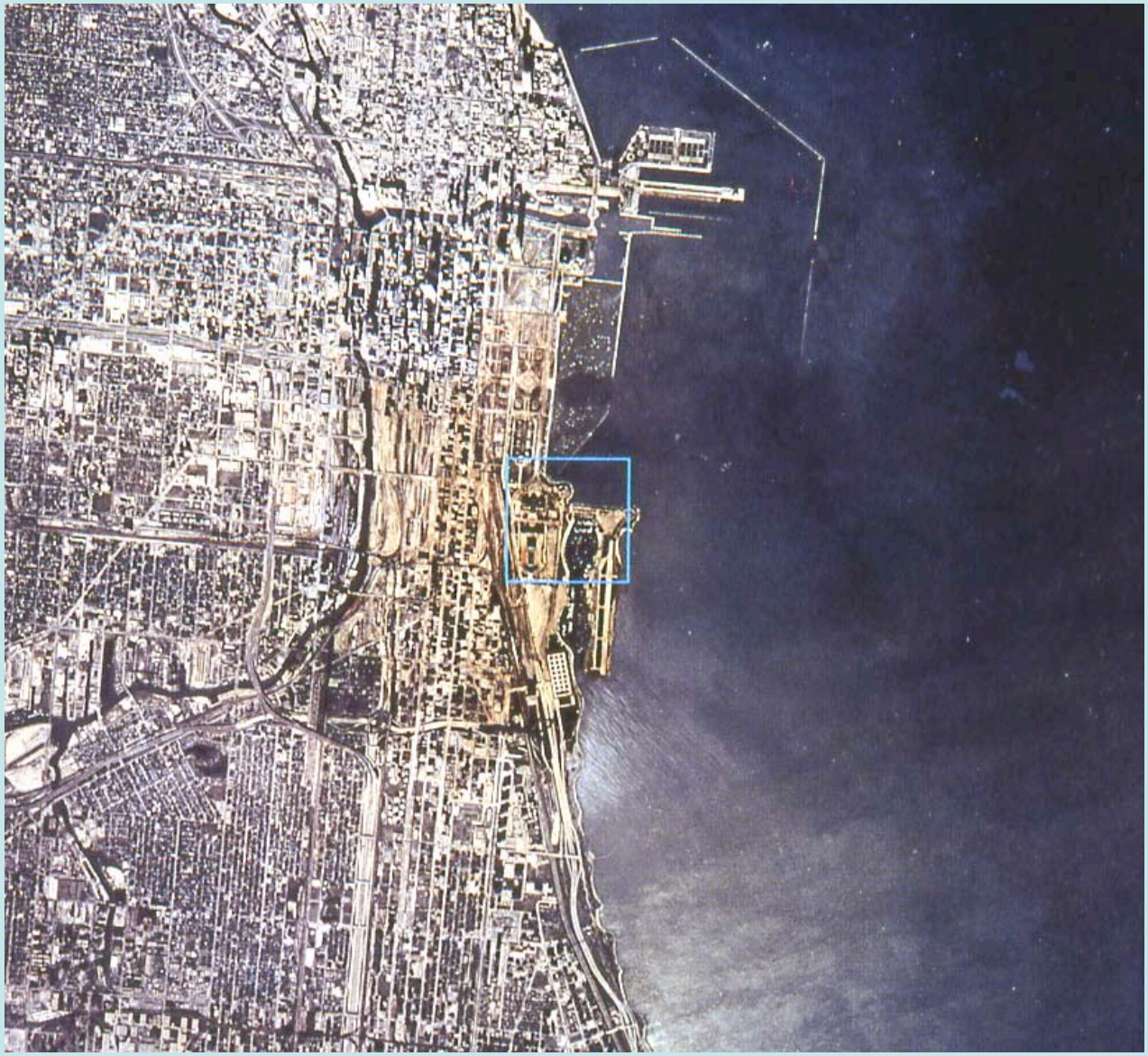
"A brilliant pictorial and textual embodiment of a wonderful idea."

— Stephen Jay Gould, *The New York Times Book Review*

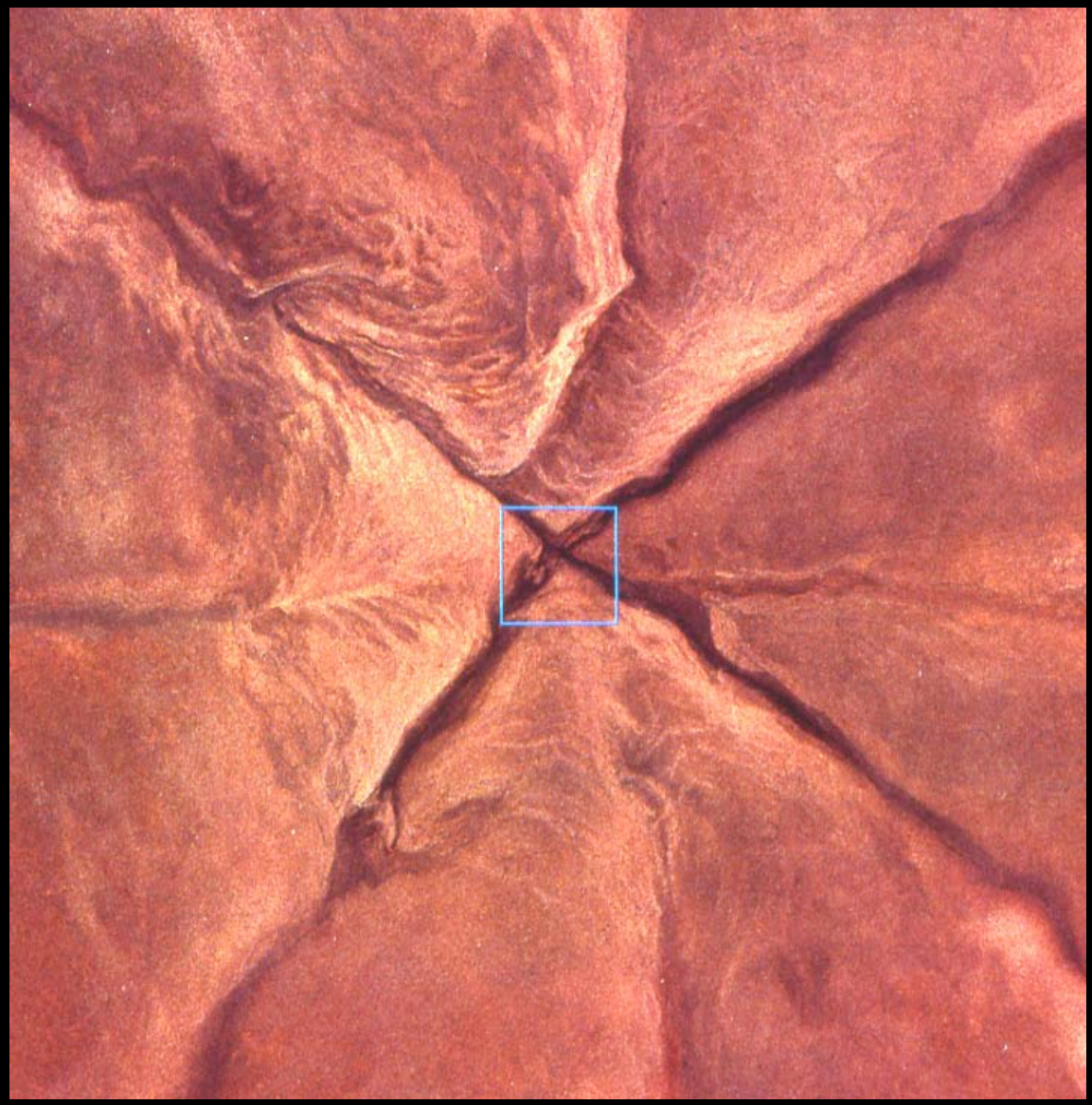


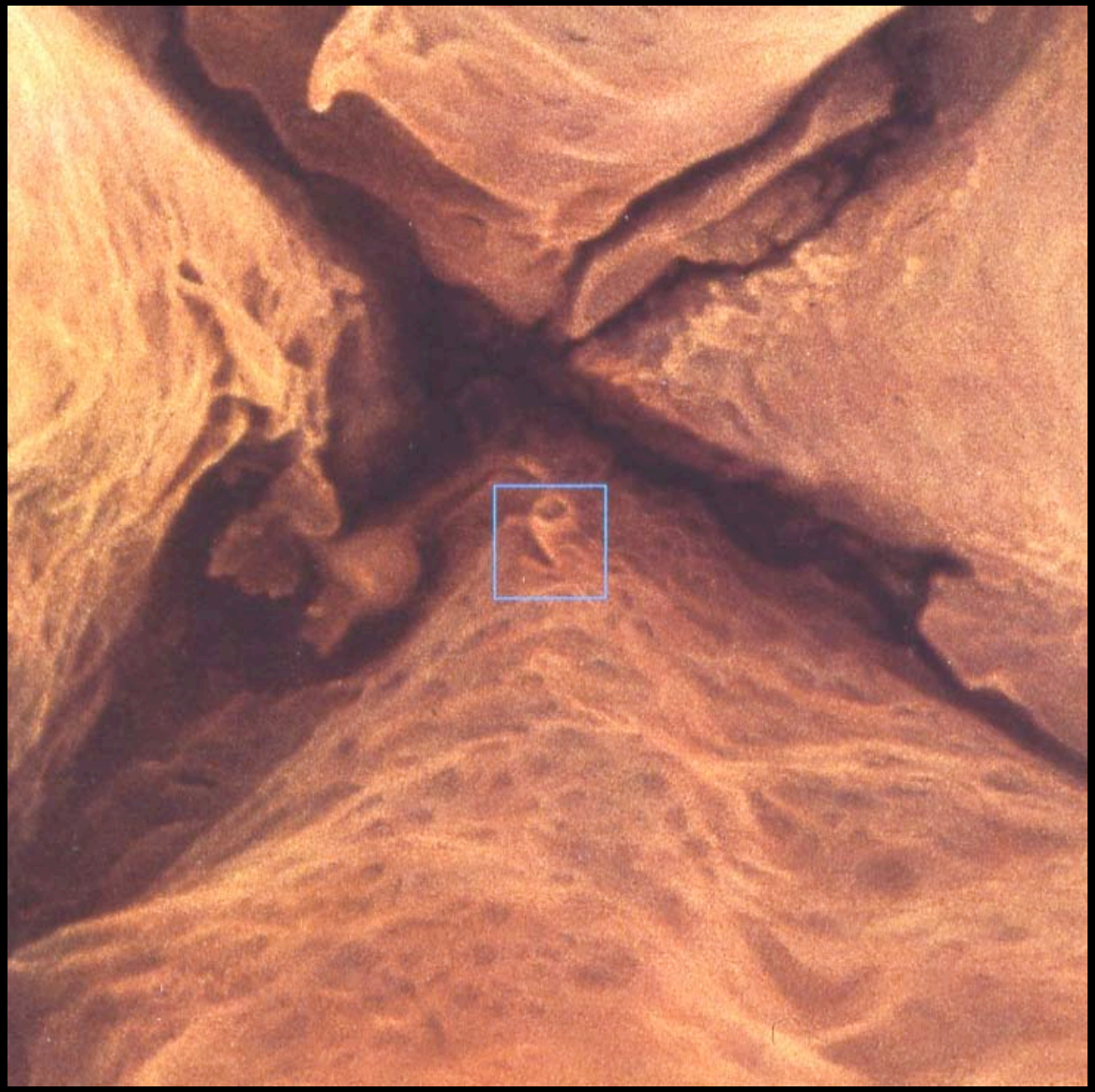






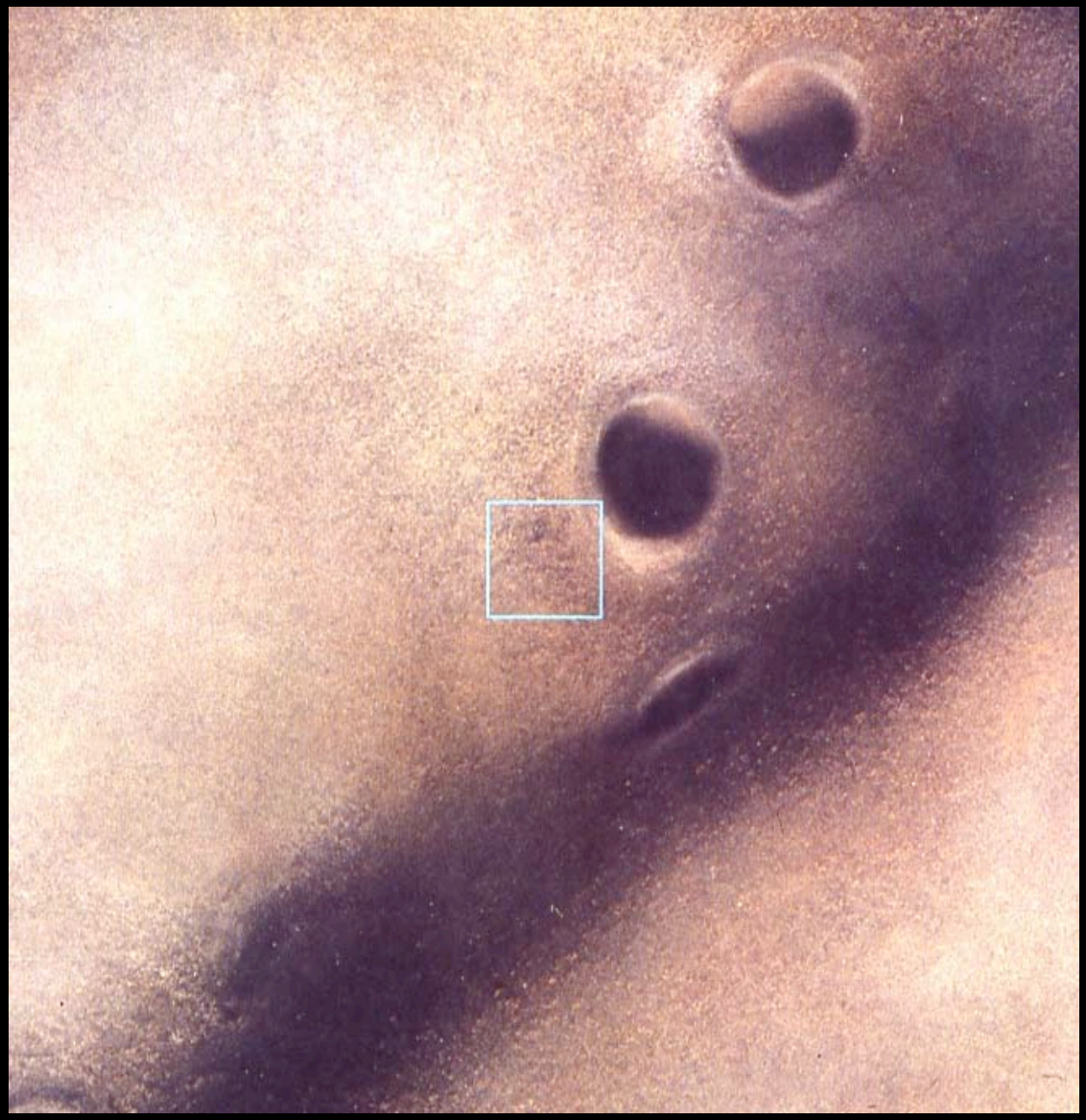
Why is this man sleeping?



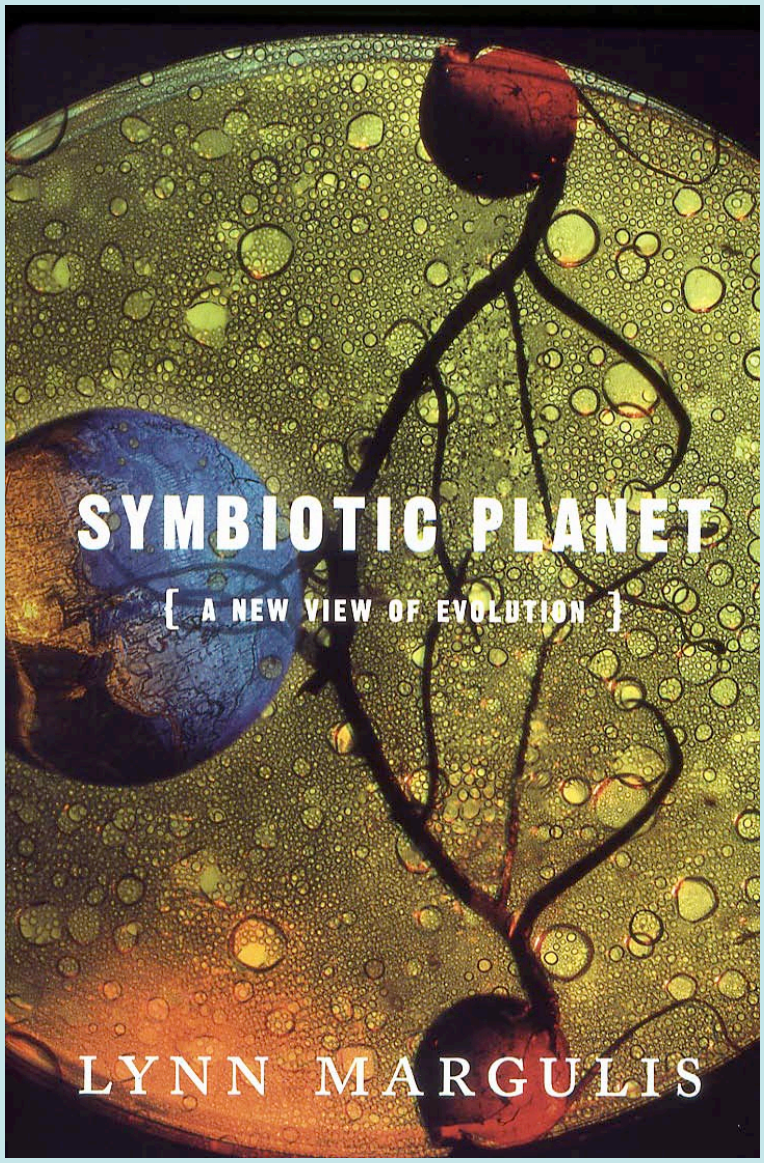


Lymphocyte

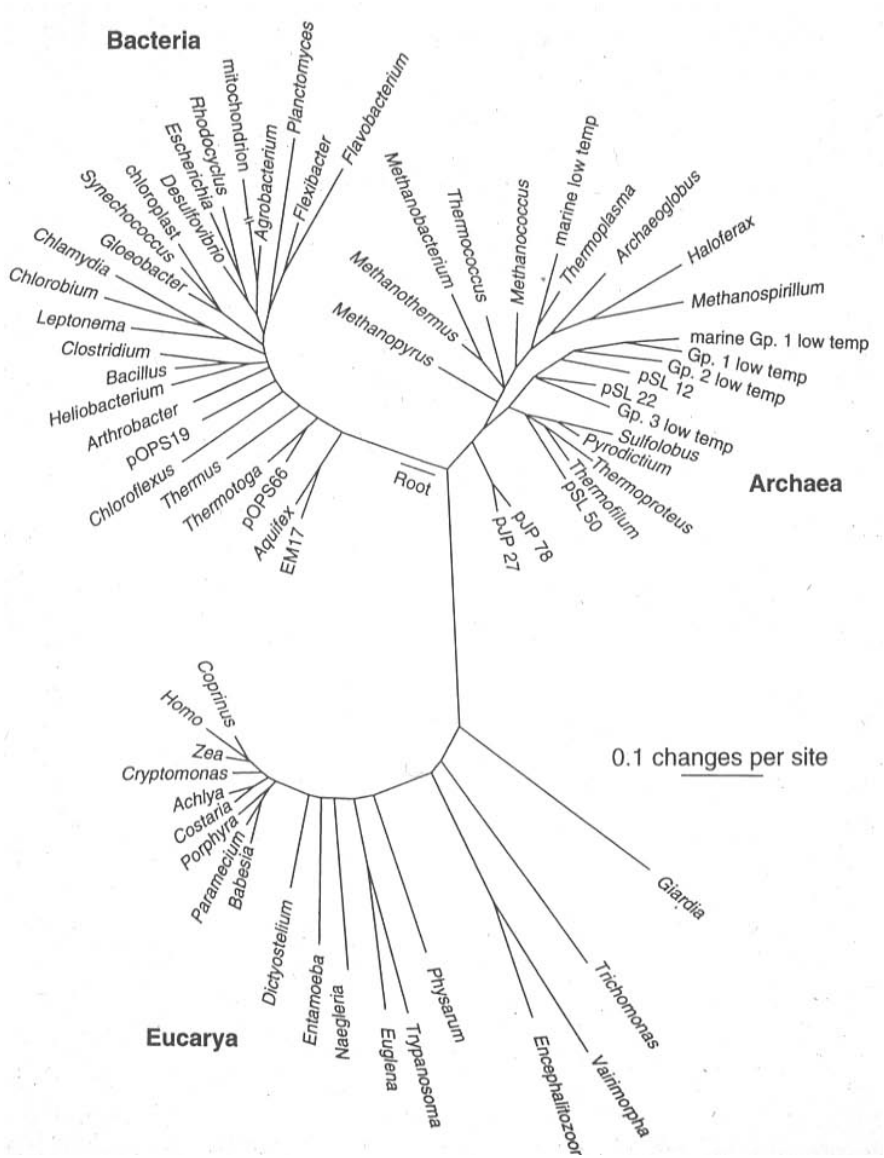
Nuclear Envelope



Chromosomal DNA

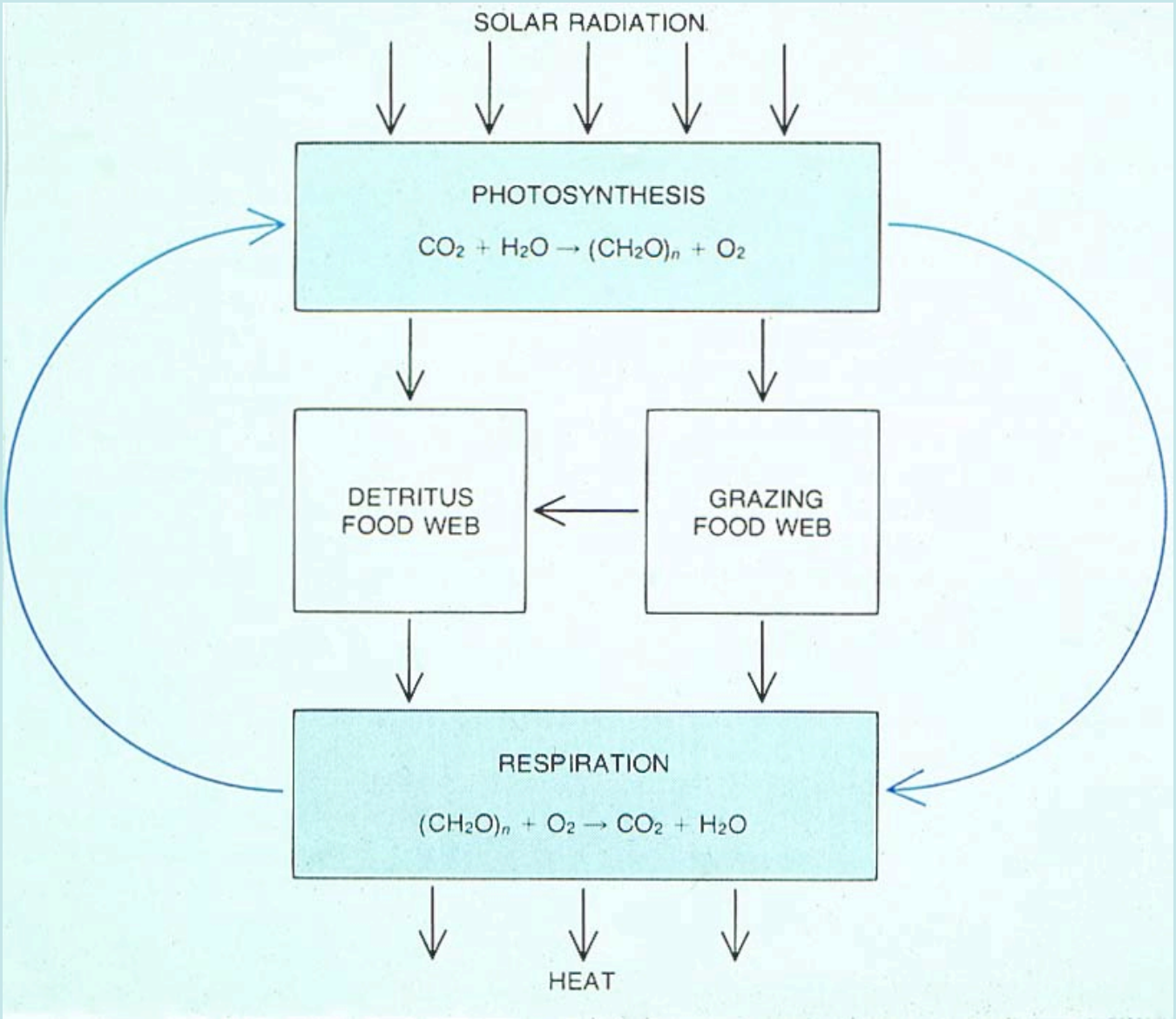

SYMBIOTIC PLANET
[A NEW VIEW OF EVOLUTION]
LYNN MARGULIS

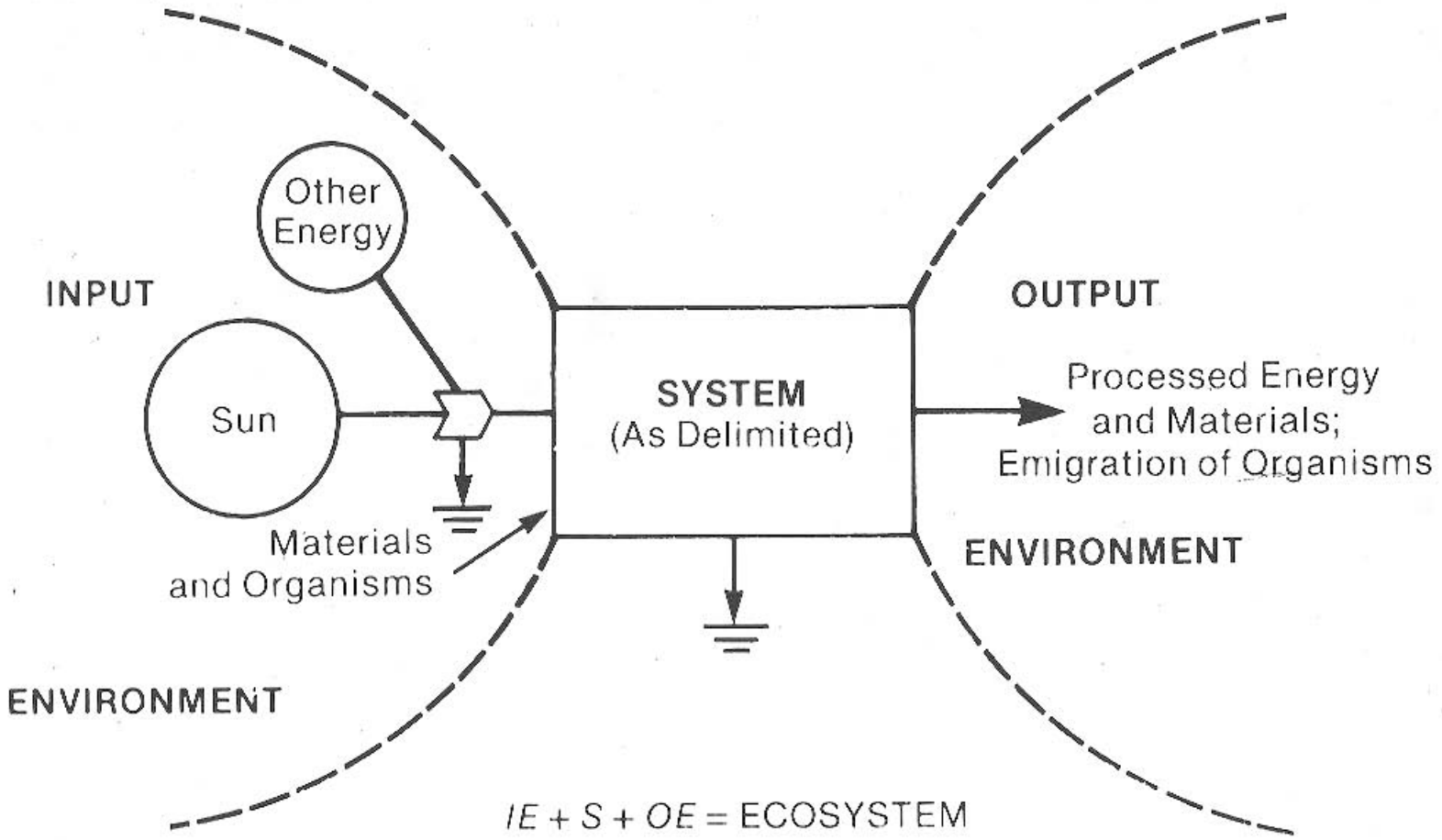
Evolutionary and Genetic Relationships



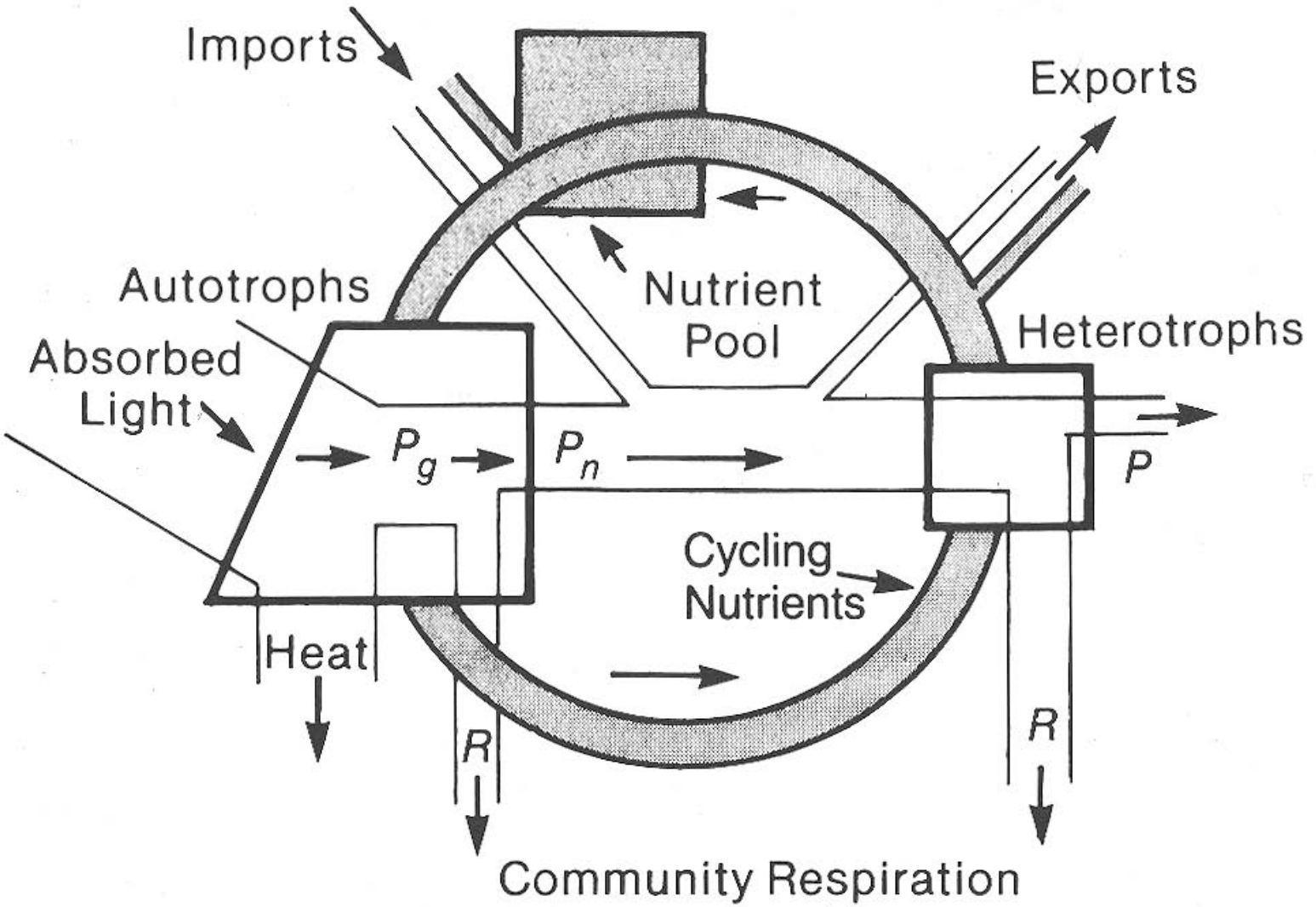
Some General Ecological Principles

General Scheme For Most Life On Earth



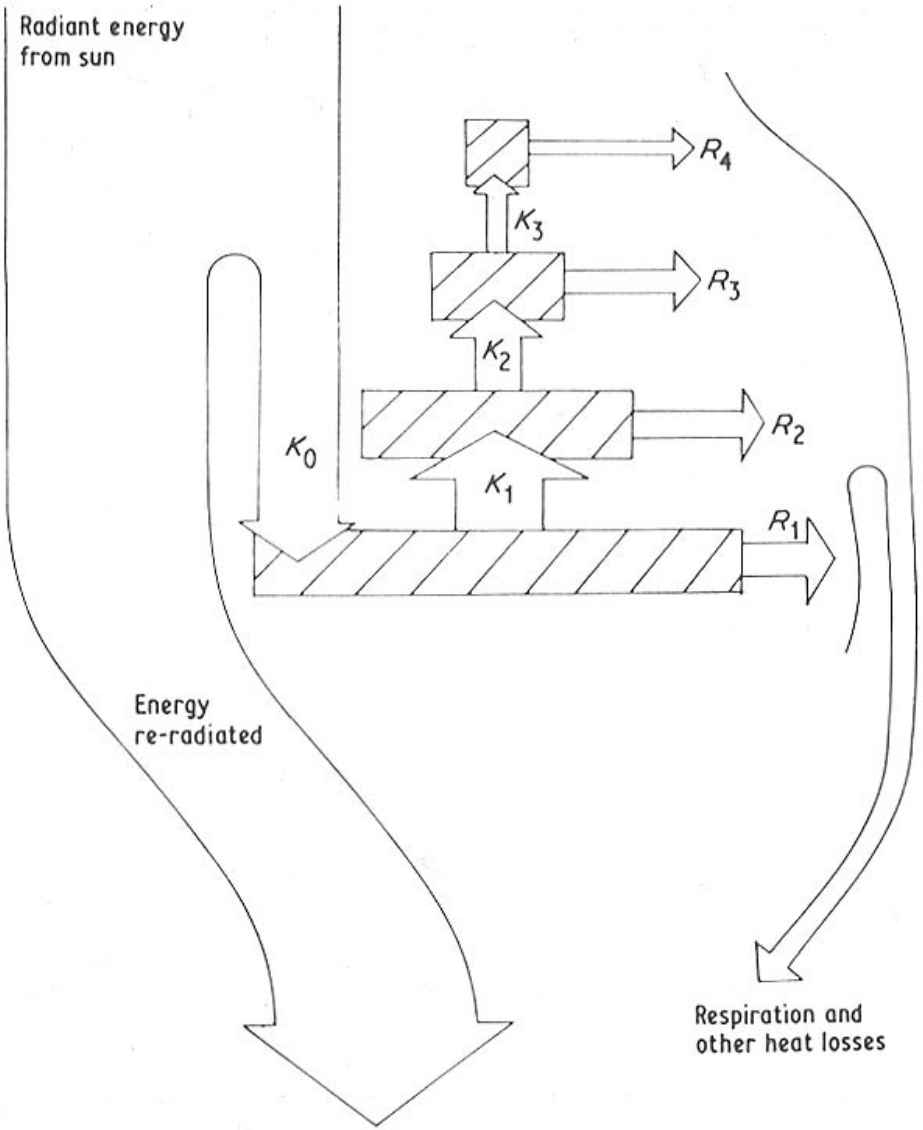


from Odum, *Fundamentals of Ecology* Saunders Pubs. 1971



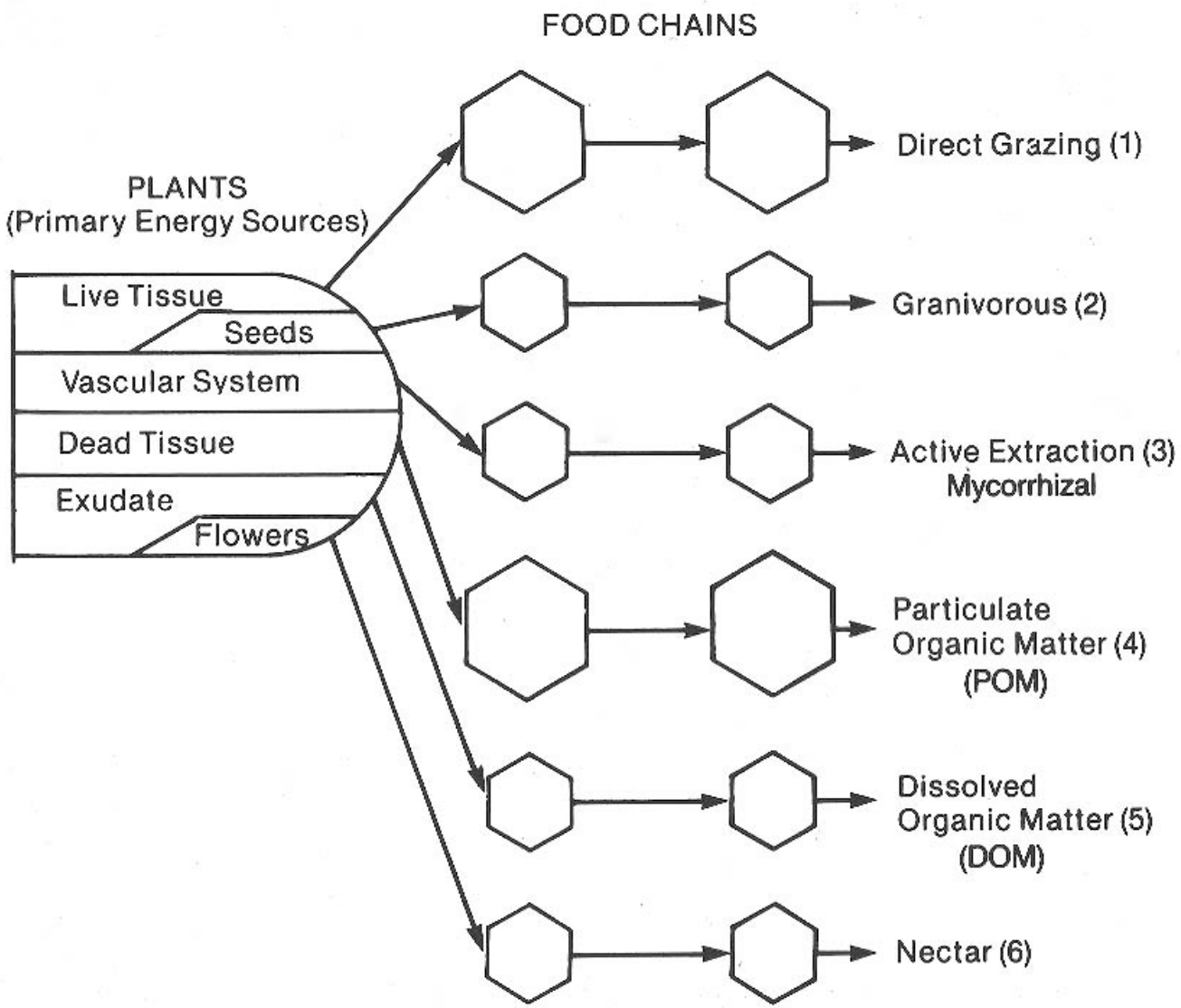
from Odum, *Fundamentals of Ecology* Saunders, Pubs.1971

Trophic Levels And Energy Flow



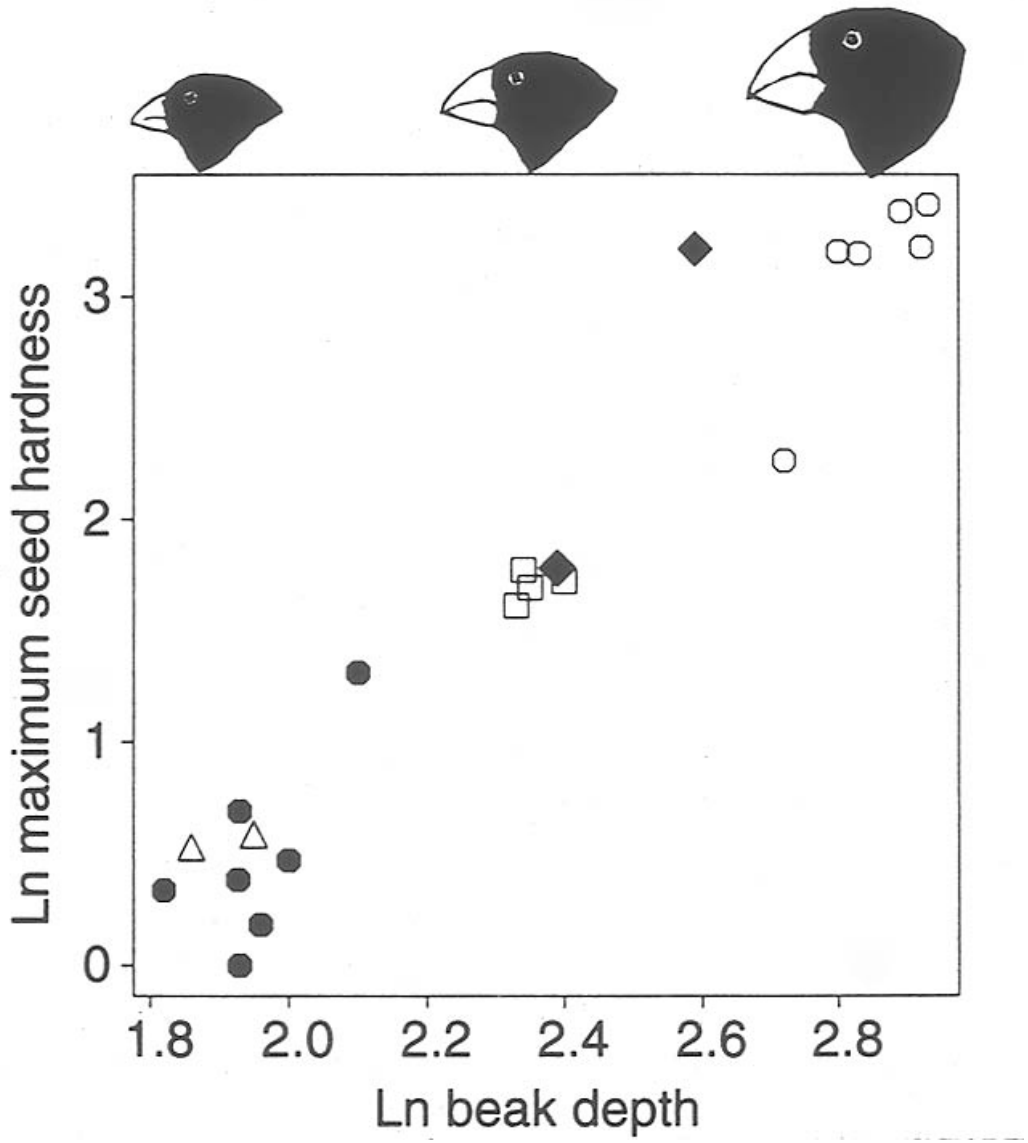
From Odum, *Fundamentals of Ecology*, Saunders Pubs.1971

Nature Abhors A Vacuum

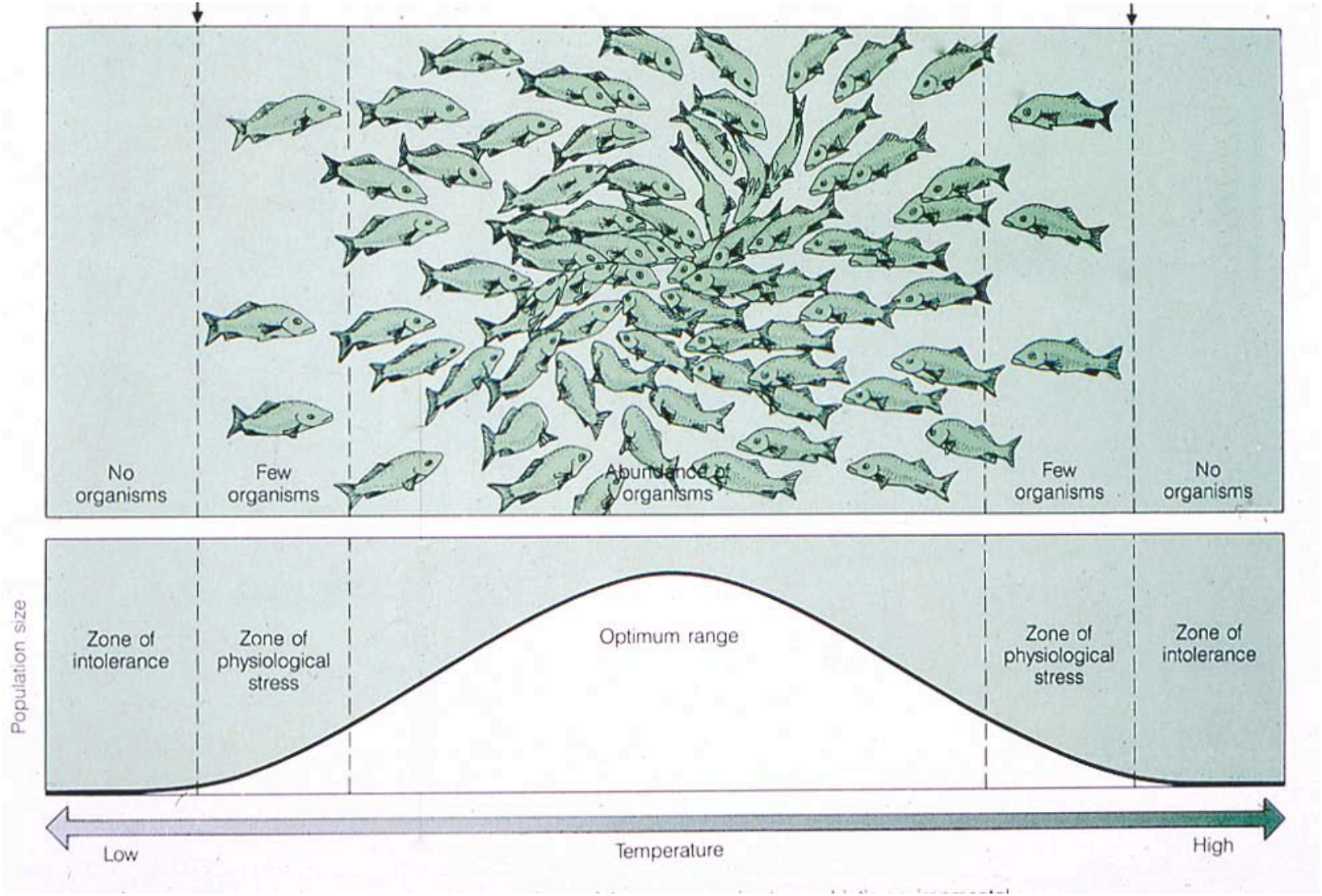


from Odum, *Fundamentals of Ecology*, Saunders, Pubs. 1971

Evolution of Darwin's Finches

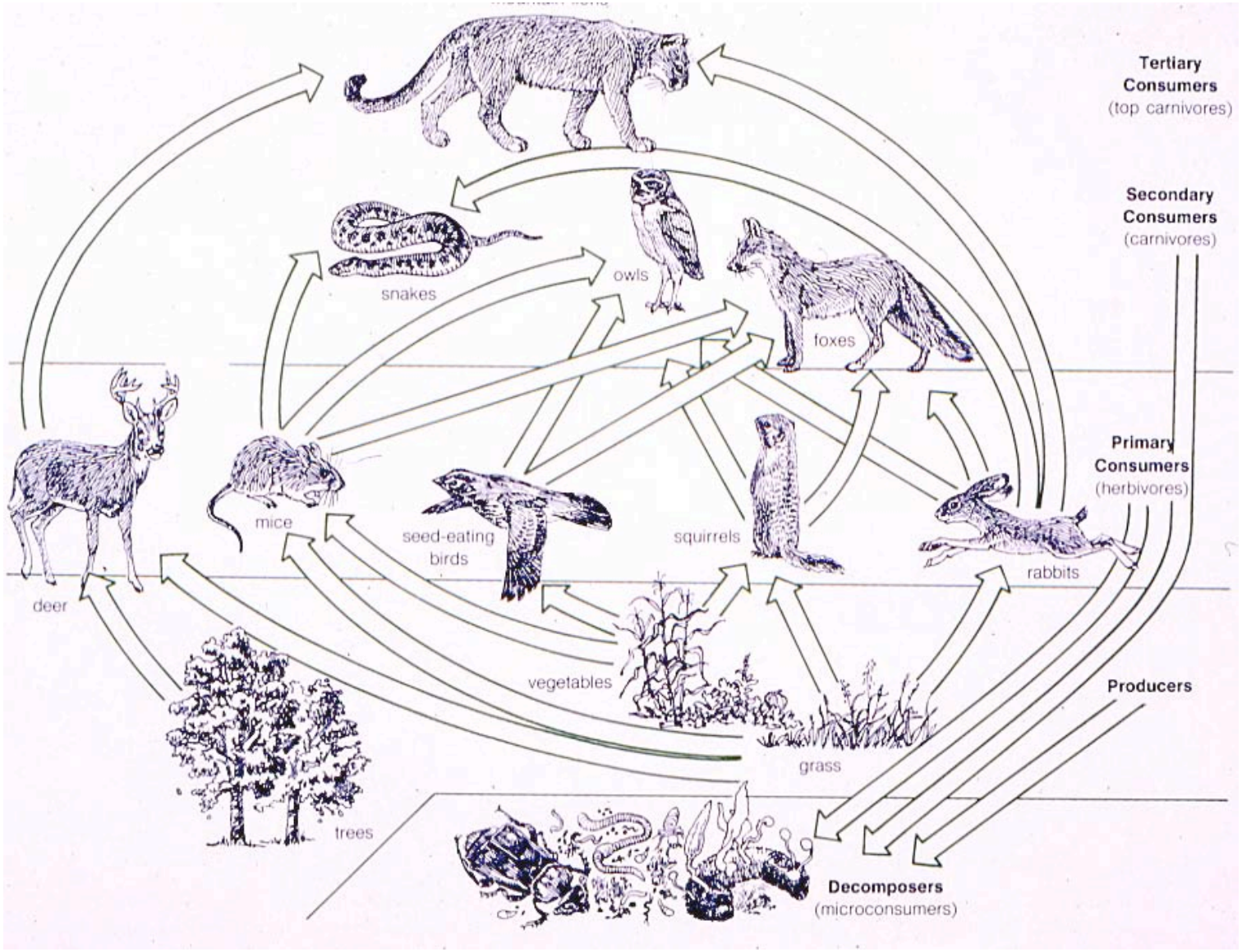


Tolerance Limits



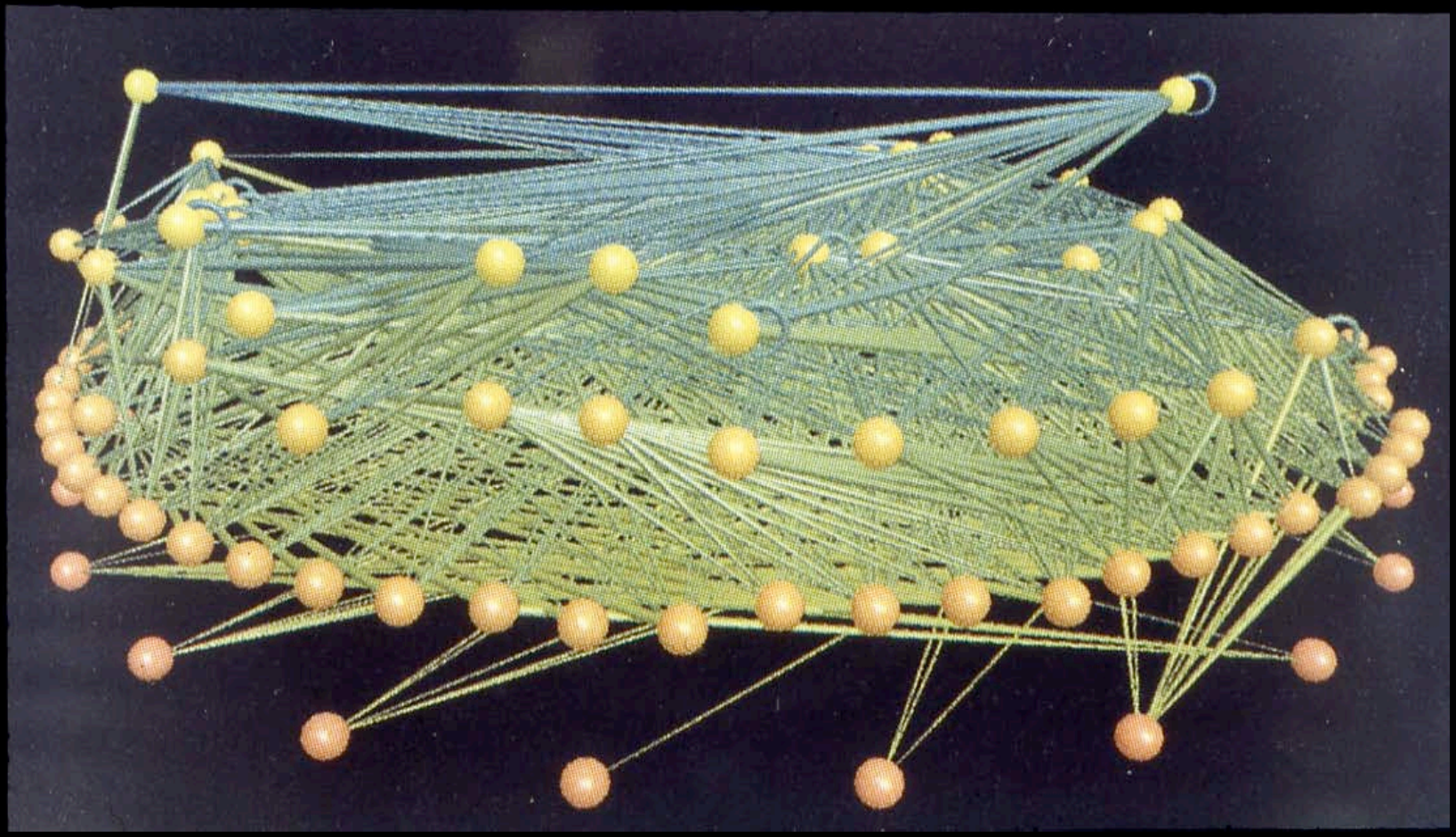
from Miller, *Living In The Environment* Thompson, Pub.

Trophic Levels and Food Webs



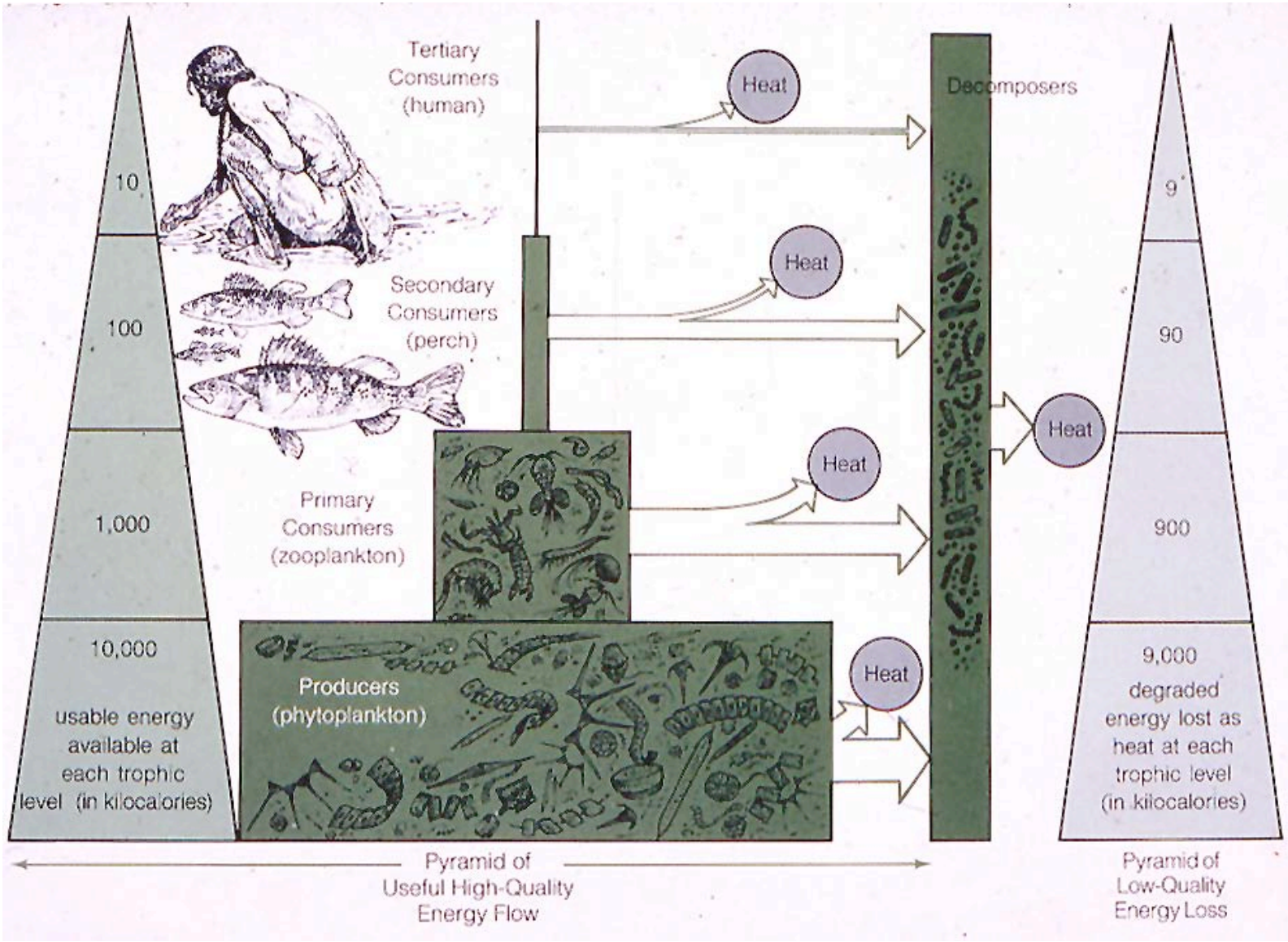
from Miller, *Living In The Environment* Thompson, Pub.

Trophic Levels and Food Webs
(who's eating who)



Science Magazine

Food Pyramids



from Miller, *Living In The Environment*, Thompson, Pub.

WebElements: the periodic table on the world-wide web

http://www.webelements.com/

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	darmstadtium 110 **Ds** [271]	ununnium 111 **Uuu** [272]	unumbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

Key:

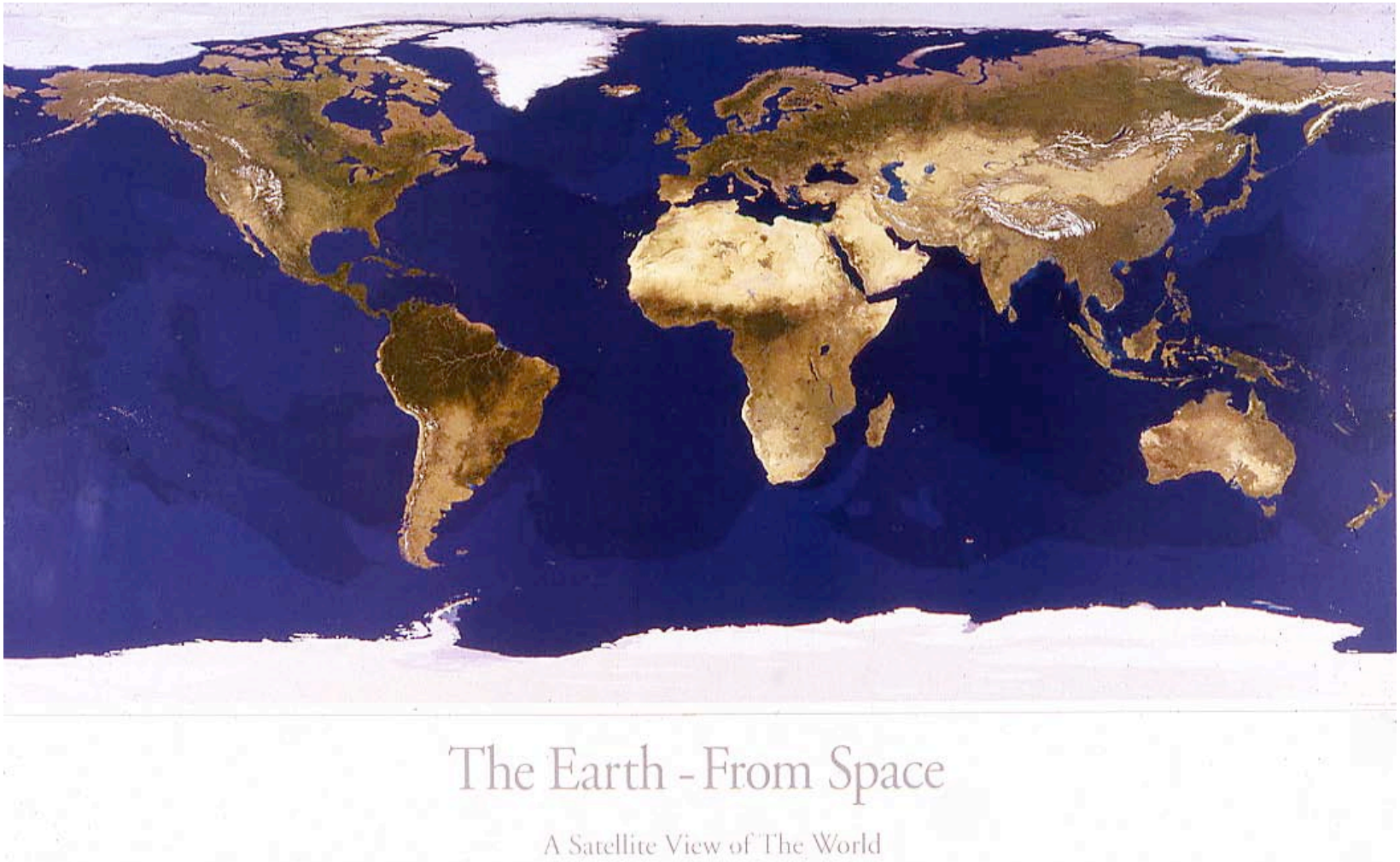
element name
atomic number
symbol
atomic weight (mean relative mass)

*lanthanoids	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**actinoids	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

Symbols and names: the symbols and names of the elements, and their spellings are those recommended by the International Union of Pure and Applied Chemistry (IUPAC - http://www.iupac.org/). Names have yet to be proposed for the most recently discovered elements 111–112 and 114 so those used here are IUPAC's temporary systematic names. In the USA and some other countries, the spellings **aluminum** and **cesium** are normal while in the UK and elsewhere the common spelling is **sulphur.**

Group labels: the numeric system (1–18) used here is the current IUPAC convention.

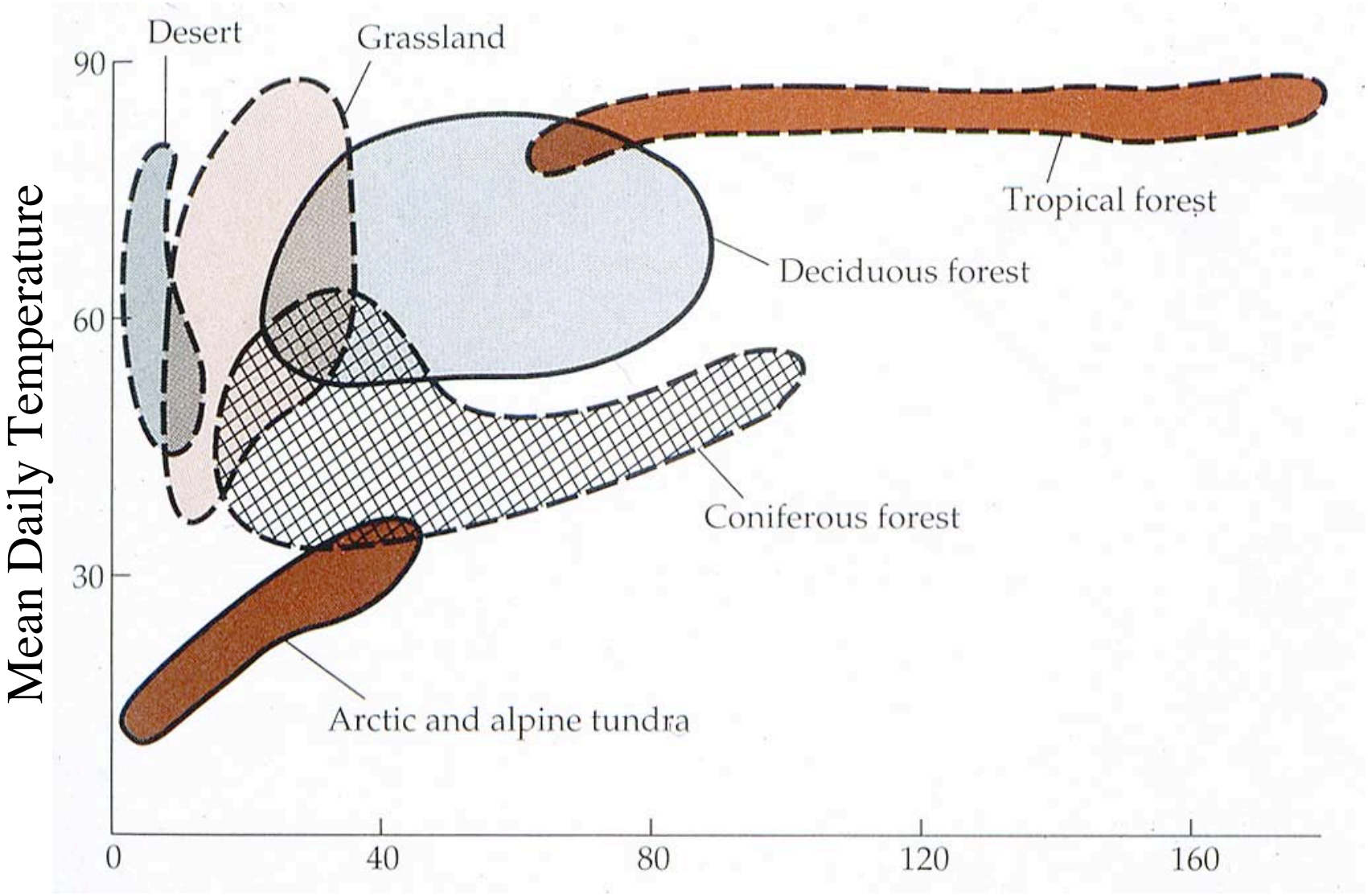
Atomic weights (mean relative masses): Apart from the heaviest elements, these are the IUPAC 2001 values and given to 5 significant figures. Elements for which the atomic weight is given within square brackets have no stable nuclides and are represented by the element's longest lived isotope.



Courtesy *NASA*

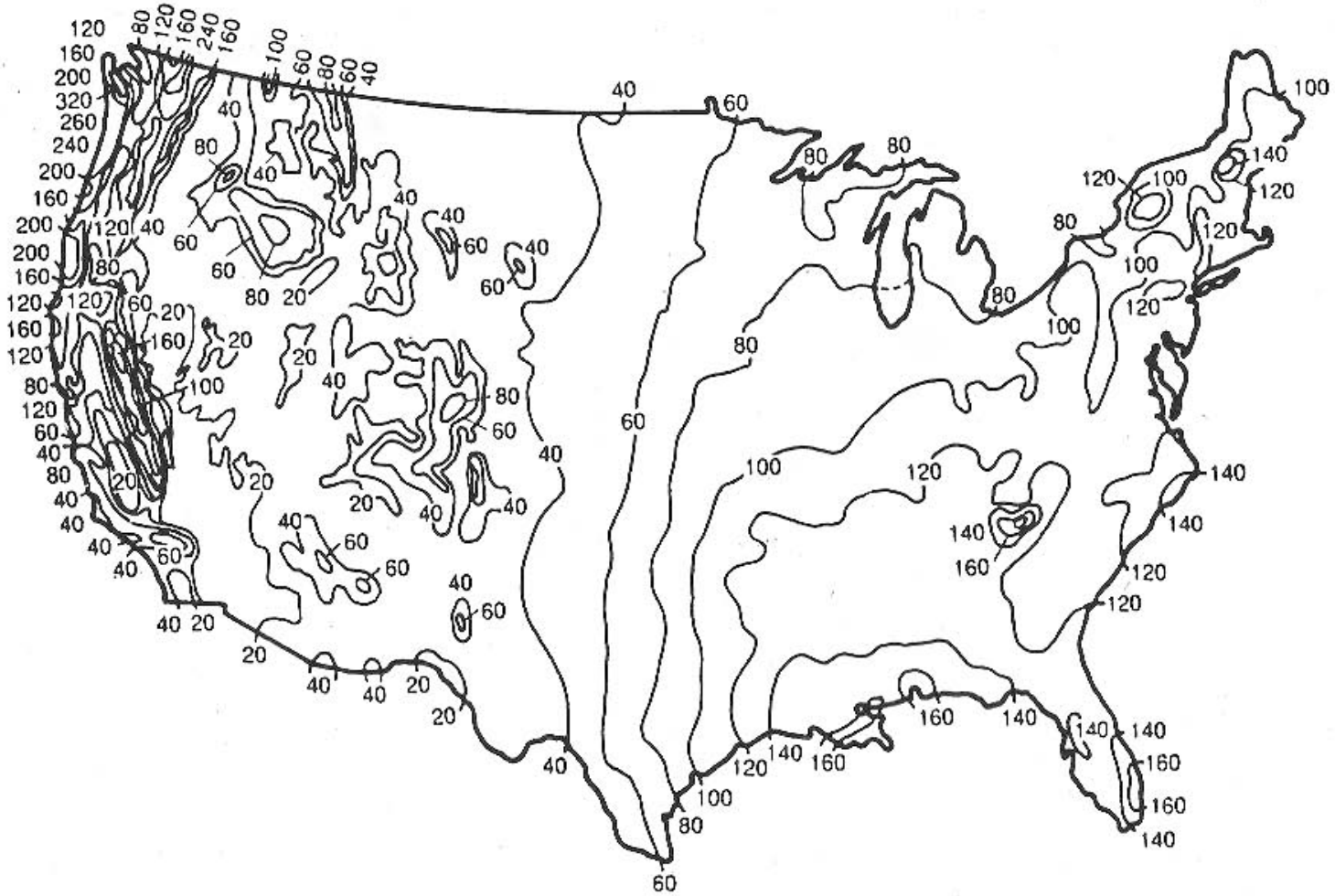
The Earth At Night

Physical Determinants Of Ecosystems



from Miller, *Living In The Environment* Thompson Pub.

Annual Mean Precipitation



Ecozones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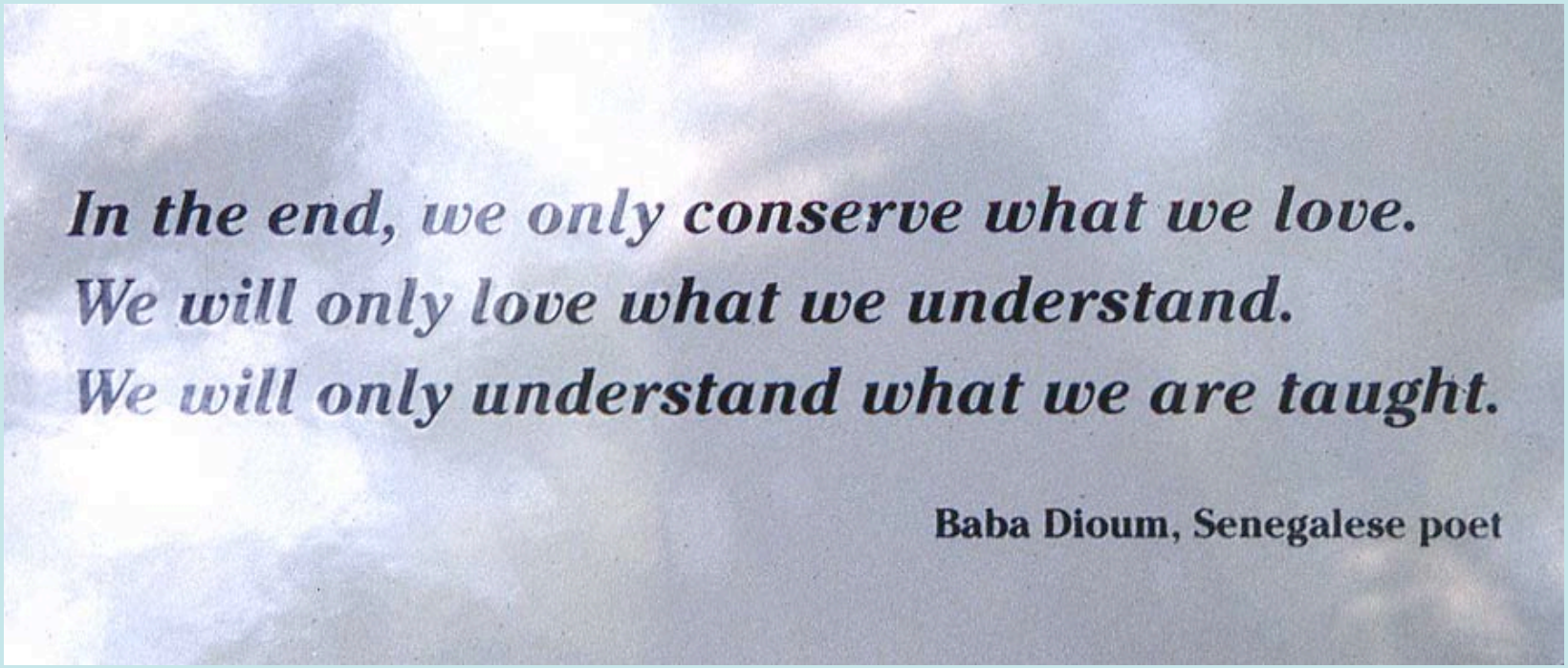
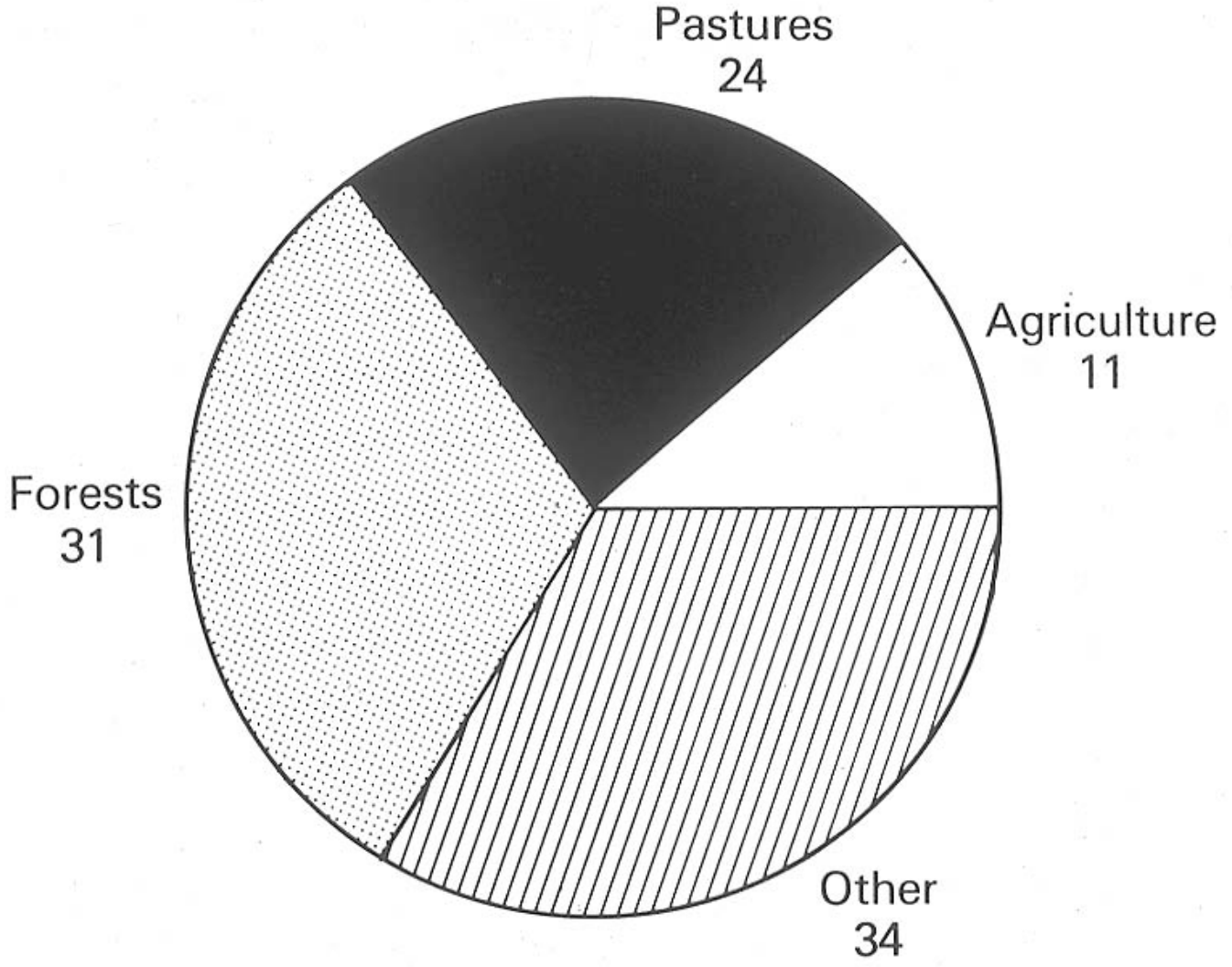

In the end, we only conserve what we love.
We will only love what we understand.
We will only understand what we are taught.
Baba Dioum, Senegalese poet

Land Use *(in percentage)*



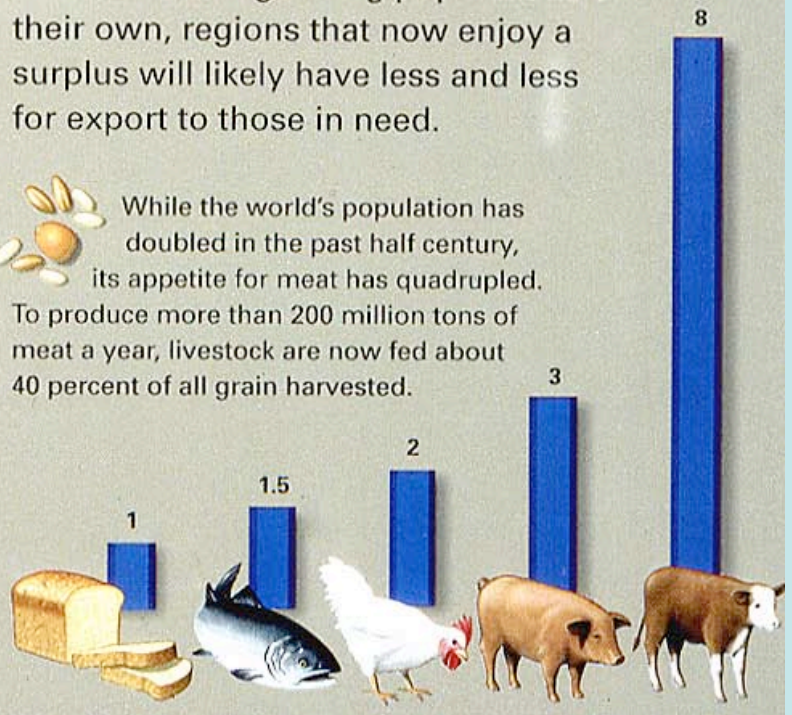
Golden harvests from the good earth

"More than 99 percent of our food comes from the land," says David Pimentel, an agricultural scientist at Cornell University. "That's a fact that a lot of people don't appreciate." Among the many crops cultivated, grains provide at least 80 percent of food worldwide. Farmers and consumers alike benefit from grains' advantages. Yields per acre are normally abundant. Also, grains store and transport well—unlike potatoes, for instance, which are swollen with water—and they contain a nutritious mix of carbohydrates, proteins, and vitamins.

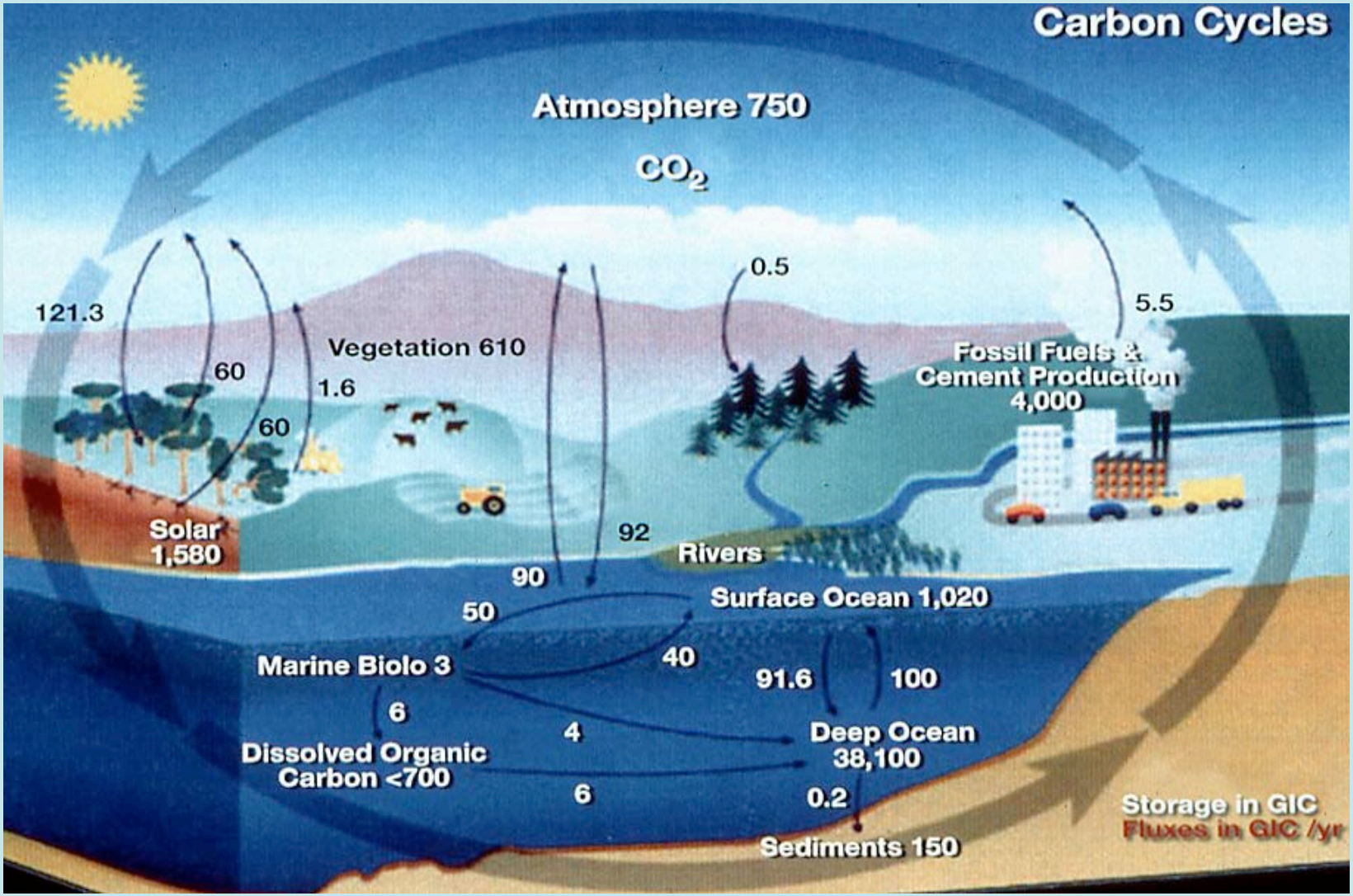
Just three crops—wheat, rice, and corn—dominate grain production. This specialization has helped drive the agricultural boom of the past 30 years, as investments in equipment and supplies targeted to one kind of plant over many acres paid off with bumper crops. Relying so heavily on such a narrow genetic base is risky, however. One virulent disease could cause crop failure and famine.

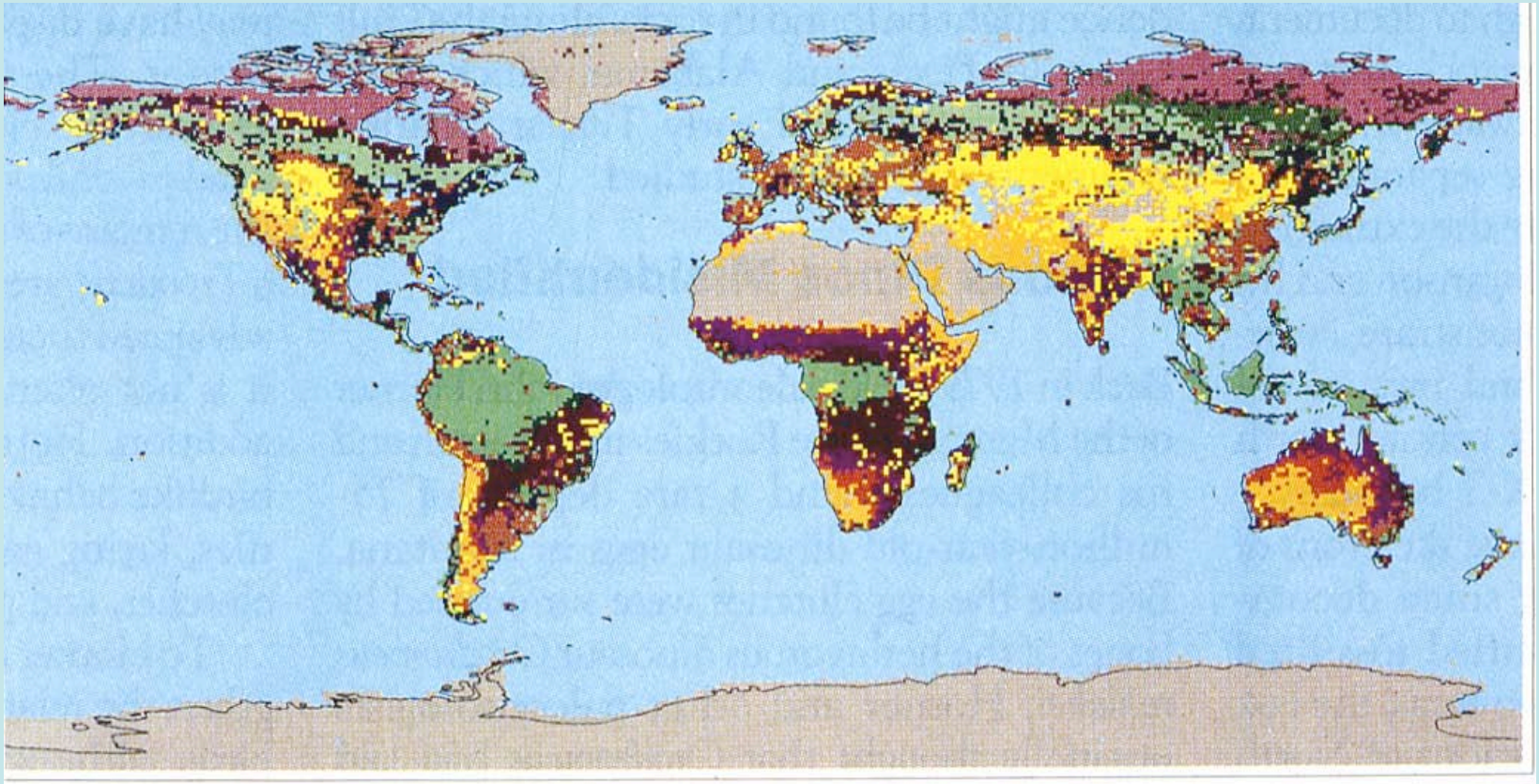
Even if crops stay healthy and cereal grain production continues to climb as projected above, the global food supply may ultimately fall short. With growing populations of their own, regions that now enjoy a surplus will likely have less and less for export to those in need.

While the world's population has doubled in the past half century, its appetite for meat has quadrupled. To produce more than 200 million tons of meat a year, livestock are now fed about 40 percent of all grain harvested.

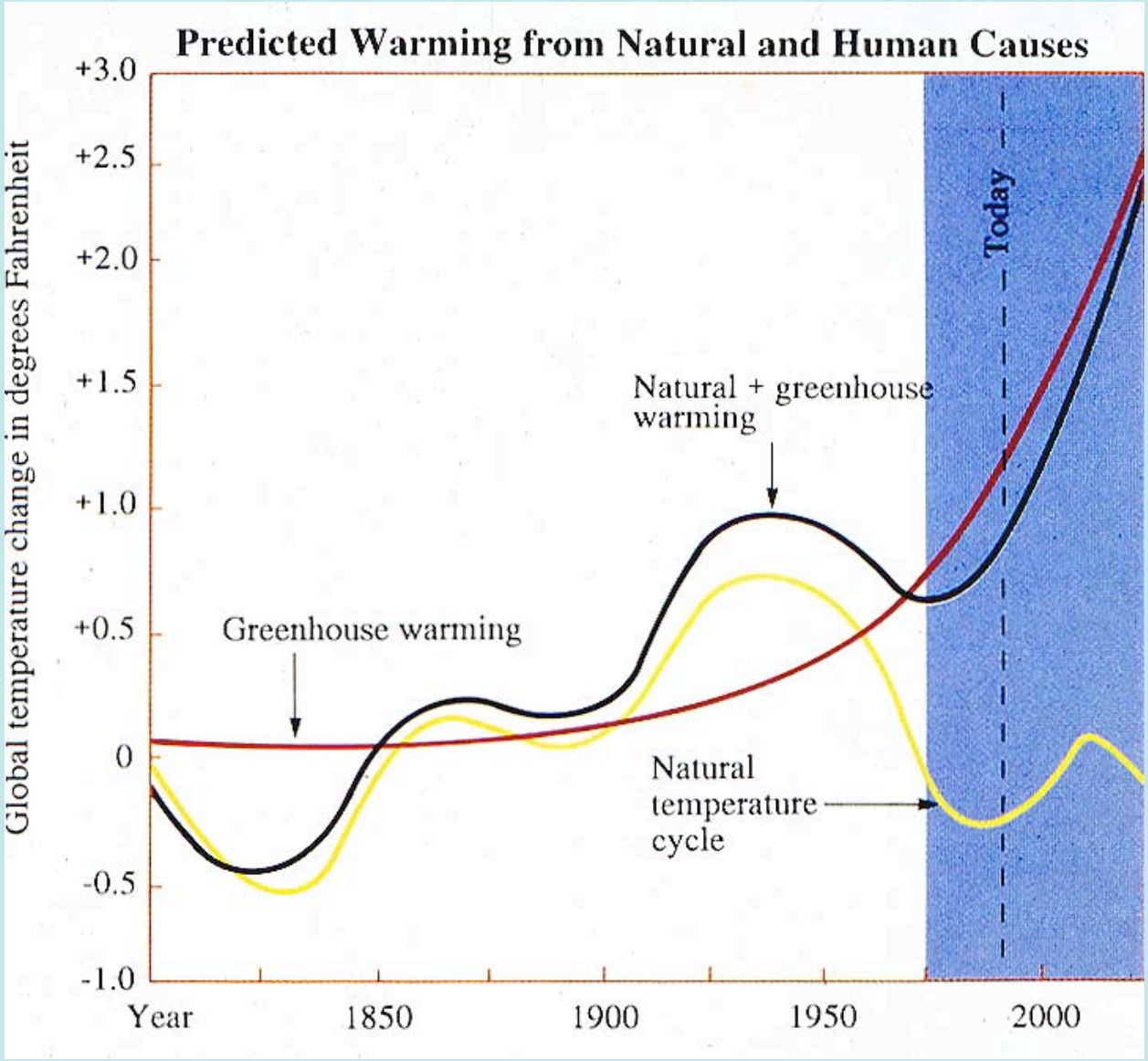


Pounds of grain needed to produce one pound of bread or one pound of live weight gain in each animal.


Carbon Cycles
Atmosphere 750
CO_2
121.3
60
60
Vegetation 610
1.6
0.5
5.5
Fossil Fuels &
Cement Production
4,000
Solar
1,580
92
Rivers
90
50
Surface Ocean 1,020
Marine Biolo 3
40
91.6
100
6
4
Dissolved Organic
Carbon <700
Deep Ocean
38,100
6
0.2
Sediments 150
Storage in GIC
Fluxes in GIC /yr



Carbon sink. Two years after a warming, global plant growth seems to suck up excess CO_2.



Science Magazine

Just When We Thought We Understood How Things Worked!

CARNIVOROUS HIPPOS Although the hippopotamus's usual fare is grass, this habitual vegetarian can occasionally turn carnivore. Field biologist Joseph P. Dudley, formerly at Hwange National Park in Zimbabwe, observed a male hippo killing an impala ram that had

DAVID HOSKING; PHOTO RESEARCHERS, INC.

swum through a pond to evade a wild dog. After eating some of the meat, the hippo returned to his herd. A few minutes later, ten more individuals from the group gathered at the floating carcass for a communal feast.

Determining the course grade:

25% - Midterm

25% - Final

30% - 10 abstracts. Each one must be a minimum of 300 and not exceed 500 words in length.

20% - 2 oral presentations

Writing an abstract:

The abstract is based on internet research of a question supplied by the presenter. Examples of faculty-generated abstracts can be found on Courseworks. Each student is required to submit 10 abstracts by e-mail to their TA. They will be graded and returned ASAP by e-mail. One of three grades will be given: Good, Fair, Poor. Three internet sites are required to be used for all 10 abstracts:

www. http://ci.columbia.edu/ci/eseminars/1111s_detail.html

www.EPA.gov

and one other.gov site – e.g., www.USDA.gov; www.NIH.gov; www.CDC.gov; www.NOAA.gov; www.USGS.gov