

Not to see me
Dress Code



HUMANISTIC PERSPECTIVES IN THE SCIENCES;
GAIA HYPOTHESIS AND BEYOND

Unique of
Ecofem/Gaia
conf

- I. MALE/FEMALE PERCEPTIONS AND SCIENCE - CLASSROOM EXERCISE
 - A. STUDENT UNDERSTANDING OF ACTUAL PROCESS AND PURPOSE OF SCIENCE - LIST INCLUDED ITEMS FROM UNDERSTANDING TO CONTROL AND DIRECTION OF NATURAL PROCESSES
 - B. CHARACTERIZE DIFFERENCES MALE x FEMALE (FOOT IN MOUTH)
 1. SEVERAL STUDENTS FROM WOMEN'S STUDIES CLASSES OBLIGED (DOMINATE, NEED TO CONTROL, SEPARATION FROM OTHERS) *FEAR CRY*
 2. MALE VOICE: WOMEN ARE BITCHY ...
 - C. COMPARE LISTS TO SCIENCE - AND PERCEPTION OF SCIENCE AS MASCULINE PURSUIT IS OBVIOUS
 - D. CONSTRUCT ALTERNATIVE PERSPECTIVE ON WAYS TO RELATE TO NATURAL WORLD [SEPARATE 'WOMEN IN SCIENCE' FROM FEMINIST SCIENCE]
 1. MAINTAIN RELIABILITY, REPRODUCABILITY, FALSIFIABILITY, EMPIRICISM
 2. QUESTION DEEP-ROOTED CULTURAL BIASES INHERENT IN PROCESS OF MODERN SCIENCE
 3. HYPOTHESIS EXISTS WHICH BOTH RESPONDS TO FEMINIST CRITICISMS OF SCIENCE AND MAINTAINS RIGOR OF TRADITIONAL SCIENCE: GAIA
 4. BULK: PRESENT OVERVIEW OF HYPOTHESIS AS EXAMPLE OF DEVELOPING NEW PERSPECTIVE ON CONDUCTING SCIENTIFIC RESEARCH
 - THEN: IDEAS LIB ARTS RELATIONS
 5. WITH APOLOGIES : *Dress Code - Expertise*

II. THE GAIA HYPOTHESIS

A. BACKGROUND

IN THE LATE 1960'S A BRITISH SCIENTIST, JAMES LOVELOCK, HIRED BY NASA TO DETERMINE HOW TO DETECT LIFE ON MARS, ENDED UP PROPOSING THAT NOT MARS, BUT EARTH WAS ALIVE. BY THIS, HE MEANT THAT THE EARTH ITSELF BEHAVED AS A SELF-REGULATING SYSTEM. INSTEAD OF THE CONVENTIONAL VIEW THAT LIFE EXISTS ONLY BECAUSE MATERIAL CONDITIONS ON EARTH HAPPEN TO BE JUST RIGHT, HE ARGUED THAT LIFE ITSELF DEFINES THE MATERIAL CONDITIONS NEEDED FOR ITS SURVIVAL AND MAKES SURE THEY STAY THERE!

IN THE ENSUING TWO DECADES, HIS IDEAS AND THE WORK IN PARTICULAR OF LYNN MARGULIS ^(Boston Univ.) HAVE GENERATED NOT ONLY CONTROVERSY, BUT AN AMAZING AMOUNT OF NEW TYPES OF RESEARCH. ABOUT 150 OF THESE WORKERS MET IN THE WINTER OF 1988 AT THE AGU CHAPMAN CONFERENCE ON THE GAIA HYPOTHESIS. AT THIS MEETING IT BECAME CLEAR THAT NO ONE REALLY KNEW HOW TO EVEN STATE THE HYPOTHESIS IN TESTABLE TERMS MUCH LESS DEFINE 'LIFE'. NONETHELESS, SCIENTISTS AT MANY MAJOR UNIVERSITIES AND RESEARCH CENTERS PRESENTED WORK DONE IN GAIAN TERMS AND SHOWED THAT SO-CALLED MAINSTREAM SCIENTISTS WERE USING TECHNOLOGIES AND POSING QUESTIONS THAT FIT GAIAN PERSPECTIVES. THERE WAS A SENSE THAT SCIENCE WAS BEGINNING TO MATURE ADEQUATELY TO HANDLE COMPLEX ISSUES. THE GAIAN FOCUS IS ON SYSTEMS ANALYSIS AND

INTERDISCIPLINARY APPROACHES, TWO NECESSARY PREREQUISITES TO EXAMINING GLOBAL ISSUES SUCH AS GREENHOUSE, OZONE, ACID RAIN AND TROPICAL FOREST DEVASTATION. IT STUDIES THE EARTH AS AN INTERCONNECTED LIVING SYSTEM OF WHICH HUMANS ARE A PART, RATHER THAN SIMPLY A MACHINE TO BE OPERATED.

I PROPOSE THAT GAIA MAY NOT REALLY BE AN HYPOTHESIS, BUT IS A PARADIGM WHICH IS ESSENTIAL FOR SOLVING COMPLEX SCIENTIFIC ISSUES OF SOCIAL IMPORTANCE. IT IS A PERSPECTIVE WHICH BRIDGES THE SO-CALLED HUMANITIES-SCIENCE TWO-CULTURE GAP; IT BRINGS SCIENCE INTO A REALM THAT MAKES BETTER SENSE TO THE AVERAGE TAXPAYER (OR CONGRESSIONAL REPRESENTATIVE); RESPONDING AS IT DOES TO FEMINIST CRITIQUES IT SHOULD BE AN EFFECTIVE WAY TO INTEREST AND INCORPORATE MORE WOMEN AND MINORITIES IN SCIENCE.

- B. THE HYPOTHESIS PROPER: DATES BACK TO ALCHEMISTS AND HAS SURVIVED IN VARIOUS FORMS SINCE.

JAMES HUTTON, FATHER OF GEOLOGY, PROPOSED IN 1785 THAT THE EARTH IS A SUPERORGANISM AND SHOULD BE STUDIED PHYSIOLOGICALLY. IN VIEWING THE EARTH AS A LIVING PLANET, LOVELOCK SUGGESTS THAT WE NEED TO DEVELOP THIS SCIENCE OF GEOPHYSIOLOGY. GEOPHYSIOLOGY IS THE SCIENCE OF PLANETARY MEDICINE, VIEWING THE EARTH AS A LIVING BEING, NOT AS A MACHINE. SCIENTISTS WOULD INVESTIGATE FEEDBACK LOOPS TO DEMONSTRATE THE INTERDEPENDENCY OF

THE EARTH'S CIRCULATORY SYSTEMS.

IF LIFE EXISTS AT THE PLANETARY SCALE, THESE LOOPS MUST BE GLOBAL IN EXTENT. THE KEY QUESTION SEEMS TO BE NOT WHETHER LIFE INTERACTS WITH THE PLANET, BUT WHETHER IT REGULATES THE PLANET (A SELF-REGULATING, SELF-ORGANIZING ENTITY). COMPARE TO RED QUEEN HYPOTHESIS.

LYNN MARGULIS AMPLIFIED THIS EXPLANATION REFERRING TO GAIA AS APPROXIMATELY THE SURFACE OF THE EARTH AND ARGUING THAT THE EARTH'S TEMPERATURE, ACIDITY, ALKALINITY, REDOX RELATIONS, COMPOSITION OF REACTIVE GASES ARE ALL MAINTAINED (NOT NECESSARILY CONSTANT) THROUGH TIME BY THE BEHAVIOR, GROWTH AND INTERACTIONS OF LIVING ORGANISMS. THUS, SHE VIEWS GAIA AS A COMPLEX ENTITY INVOLVING EARTH'S BIOSPHERE, ATMOSPHERE, OCEANS, AND SOIL; THE TOTALITY CONSTITUTES A FEEDBACK (CYBERNETIC) SYSTEM WHICH SEEKS TO OPTIMIZE THE PHYSICAL AND CHEMICAL ENVIRONMENT FOR LIFE.

IF WE CONCEIVE OF THE EARTH AS A SELF-REGULATING SYSTEM IN WHICH THE CLIMATE AND ENVIRONMENT ARE CONSEQUENCES OF AN AUTOMATIC, THOUGH NOT PURPOSEFUL, GOAL-SEEKING SYSTEM, THEN GAIA IS THE LARGEST MANIFESTATION OF LIFE. *LIFE AS AUTOPOEITIC* (SELF-REG { SELF-ORG

LOVELOCK, IN AGES OF GAIA, CONTINUES BY NOTING THAT GAIA IS A TIGHTLY COUPLED SYSTEM OF LIFE AND ITS ENVIRONMENT WHICH INCUDES:

Fig 1
Bio \leftrightarrow Env

- 1) LIVING ORGANISMS, SUBJECT TO THE RULES OF DARWINIAN NATURAL SELECTION.
- 2) THE PHYSICAL AND CHEMICAL CONSTRAINTS/ (i.e. ENVIRONMENT) THAT ESTABLISH THE LIMITS OF LIFE.

THIS VIEW SHOWS:

*Autopoietic Life:
Reproduction not
part of definition
(possible consequence)*

- 1) LIFE IS PLANETARY SCALE; EFFECTIVELY IMMORTAL (1/4 UNIVERSE AGE) WITHOUT NEED TO REPRODUCE.
- 2) THERE CAN BE NO PARTIAL OCCUPATION OF A PLANET BY LIFE (PART PREGNANT).
- 3) DARWIN'S ADAPTATION INCOMPLETE - BECAUSE ORGANISMS ALTER THEIR ENVIRONMENT: COUPLED PROCESS MUST BE UNDERSTOOD.

THE PROBLEM OF PERCEIVING GAIA IS NOT UNLIKE THAT ZEN PROBLEM OF SEEING THE BACK OF YOUR OWN EYEBALLS OR EVEN SEEING THE FOREST FOR THE TREES. WE ARE AN ASPECT OF GAIA. PEOPLE WHO HAVE DIFFICULTY UNDERSTANDING HOW THE PHYSICAL ENVIRONMENT IS A FUNCTIONAL ASPECT OF GAIA COULD CONSIDER THE REDWOOD TREE, WHICH CONTAINS ONLY ABOUT 1% LIVING MATERIAL, THE REST BEING INERT. PEOPLE WHO HAVE DIFFICULTY PERCEIVING GAIA FOR ITS SIZE, ARE BEING ASKED TO CONSIDER THE POSSIBILITY THAT THERE IS LIFE ON A LARGER THAN HUMAN SCALE.

THIS IS THE DIFFERENCE BETWEEN HYPOTHESIZING DEVELOPMENT OF SELF-CONSCIOUSNESS AS AN ASPECT OF NATURAL EVOLUTION (BACTERIA-SLIME-MOLD-CORTEX) OR OF

REQUIRING AN EXTRA-TERRESTRIAL SOURCE OF SELF-CONSCIOUSNESS, THUS ALIENATING SELF-AWARE CREATURES FROM THE NATURAL WORLD (THOUGH NOT NECESSARILY THE UNIVERSE!)

I WOULD SUGGEST THAT AT THE VERY LEAST, THE GAIAN PERSPECTIVE INVOLVES A KUHNIAN-LIKE PARADIGM SHIFT FROM WHICH TO PURSUE SCIENCE. GAIA IS A GUIDING PRINCIPLE FOR RESEARCH WHICH CONTRASTS NEATLY WITH 'MACHINA': THE TRADITIONAL VIEW OF EARTH AS A MACHINE, IN WHICH ORGANIC AND INORGANIC CATEGORIES ARE ASSUMED SEPARATE. INSTEAD OF PROVING THE EARTH IS ALIVE, I ASK IF WE CAN PROVE IT IS DEAD. WHICH VIEW FITS BETTER WITH OUR NATURAL EXPERIENCE? IS THE EARTH A SPACESHIP WHICH WE OPERATE OR IS IT A LIVING SYSTEM OF WHICH WE ARE A PART? WHAT EFFECT WOULD PURSUIT OF RESEARCH ON THE EARTH'S HEALTH DO FOR OUR UNDERSTANDING OF EARTH SYSTEMS? COULD SEEKING RAPPORT WITH THE EARTH DEEPEN OUR SCIENTIFIC INSIGHTS (e.g. BARBARA McCLINTOCK)? I BELIEVE THAT THE PERCEPTION WE HAVE OF OUR RELATIONSHIP WITH THE EARTH (BELONGING TO x SEPARATED, NONVIOLENT x VIOLENT, ETC) WILL DETERMINE OUR CHOICE OF GAIA x MACHINA.

(Fig. 2)
contrast
paradigms

C. TWO EXAMPLES OF SCIENTIFIC RESEARCH ON GAIA

1. COMPUTER MODELLING OF PREDICTED RELATIONSHIPS

a. GAIA IS HYPOTHESIZED TO OPERATE THROUGH A

SERIES OF SELF-REGULATED FEEDBACK LOOPS -
PRINCIPLES OF THERMOSTAT IN MAINTAINING
PHYSICAL ENVIRONMENT OVER NARROW RANGE OF
CONDITIONS

b. DAISYWORLD: EXPLORE PROPERTIES OF CLOSELY-
COUPLED BIOTA-ENVIRONMENT - IMAGINE A PLANET
AS FOLLOWS:

1) CLOUDLESS, NEGLIGIBLE ATMOSPHERIC
GREENHOUSE

2) LIFE ONLY IN FORM OF DAISIES: LIGHT AND
DARK

(a) DARK SPECIES WILL REFLECT LESS
LIGHT THAN BARE GROUND

(b) LIGHT SPECIES REFLECT MORE LIGHT
THAN BARE GROUND

3) CONSIDER EFFECT OF GLOBAL TEMPERATURE,
ALBEDO AND SOLAR LUMINOSITY

i.e. DIFFERENCE BETWEEN MEASURING TEMP
WITH THERMOMETER AND STUDYING
INTERCONNECTEDNESS

c. DAISIES, LIKE MOST PLANT LIFE, GROW BEST OVER
A RESTRICTED RANGE OF TEMP: USE 0 AT $< 5^{\circ}\text{C}$, $> 40^{\circ}\text{C}$
MAXIMUM AT 22.5°C - ONCE THE DAISIES COVER
SUBSTANTIAL PORTION OF PLANET, THEY WILL
INFLUENCE MEAN TEMPERATURE OF PLANET

d. EQUATIONS FOR DAISYWORLD (IN WATSON &
LOVELOCK, 1983 USING CARTER & PRINCE, 1981
NATURE 213)

1) COMPARATIVE GROWTH OF DAISIES

$$\begin{aligned} da_w/dt &= a_w (x\beta - \gamma) & a_b, a_w &= \text{areas} \\ da_b/dt &= a_b (x\beta - \gamma) & & \text{covered by b\&w} \\ & & & \text{daisies} \end{aligned}$$

x = fertile area

β = growth area

$$B = 1. - 0.003265(22.5 - T_1)^2 \quad \gamma = \text{death rate}$$

max growth T

parabolic

FIND T_e : EFFECTIVE TEMP OF RADIATION ON PLANET

$$\sigma (T_e + 273)^4 = S L (1 - A)$$

σ = Stefan's constant L = luminosity

S = flux constant A = albedo

TREAT PLANET AS FLAT

$$A = \alpha_g A_g + a_b A_b + a_w A_w$$

$\alpha_g = (1 - a_w - a_b) = \text{area, albedo, bare } A_{\text{ground}}$

A_g = ground area

FIX LOCAL TEMP OF DAISIES IN TERMS OF THEIR

$$\text{PARAMETER USE } (T_1 + 273)^4 = q(A - A_1) + (T_e + 273)^4$$

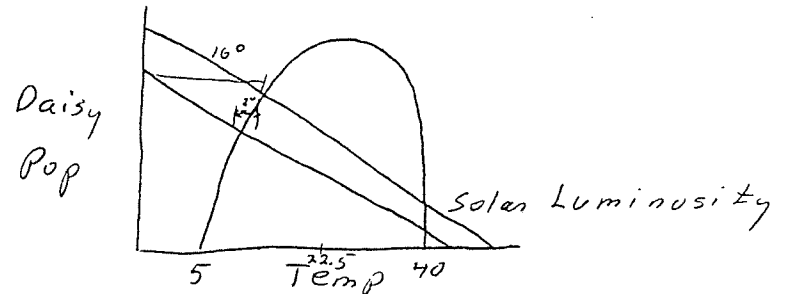
TO CALCULATE LOCAL TEMP AS F (ALBEDO)

PRESERVES ENERGY BALANCE OF PLANET

e. ?

f. STEADY STATE SOLUTION

Fig 3



(1) CURVES A & B RELATE TEMPERATURE TO DAISYWORLD POPULATION

(a) INTERSECTIONS ARE STEADY-STATE POINTS

(b) WITH 2 SLOPES SAME IS UNSTABLE - FIRST W/ OPPOSITE SIGNS OF DERIV OF CURVE IS UNCONDITIONALLY STABLE

(2) EFFECT OF CHANGING EXTERNAL ENVIRONMENT -i.e. SOLAR LUMINOSITY

(a) NO RESPONSE OF DAISY COVER TO ΔT DIFFERENCE IN PLANETARY TEMP IS 16°C

(b) IF DAISIES REACT TO ΔT ; FINAL ΔT IS 2°C

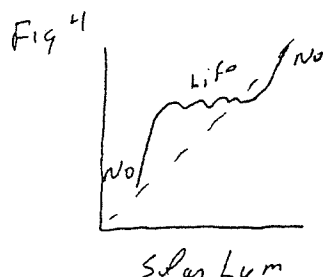
g. RESULTS OF DAISYWORLD MODELLING

(1) NO NEED TO INVENT FORESIGHT, PURPOSE OR ALTRUISM ON PART OF DAISIES, GAIA IS NOT TELEOLOGICAL

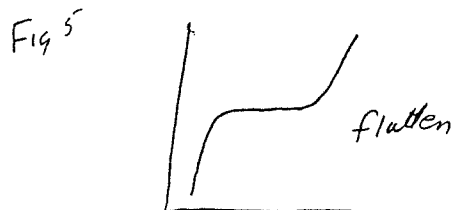
(2) MATH IS NOT LIMITED TO TWO SPECIES, BUT ONLY BY SIZE OF COMPUTER/USER PATIENCE

- (3) FEEDBACK FROM ENVIRONMENT STABILIZES EQUATIONS USED TO MODEL GROWTH/SURVIVAL OF SPECIES

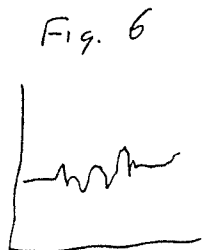
h. VARIATION ON DAISYWORLD



- (1) TEMPORAL VARIATIONS - PLOT EFFECT OF LIFE AS FUNCTION OF STEADILY INCREASING SOLAR LUMINOSITY. FOUND THAT ABOVE A CRITICAL MINIMUM DAISIES REGULATED TEMPERATURE ABOUT A CONSISTENT VALUE, UNTIL LUMINIOSITY EXCEEDED AN UPPER LIMIT OFR LIFE'S SURVIVAL



- (2) ADD DAISIES: FIRST ADDED GREY DAISIES, NOW UP TO 20 MULTI-COLORED DAISIES. FINDING GREATER DIVERSITY STABILIZES SYSTEM OF REGULATION



- (3) MODEL WORLD WITH RABBITS EATING DAISIES, FOXES EATING RABBITS AND REPEATED DISASTERS DESTROYING SUBSTANTIAL PERCENTAGE OF DAISIES

- (a) MEASURE HEALTH OF WORLD BY ABILITY TO RESIST PERTURBATION AND RAPIDITY/SMOOTHNESS OF RETURN TO NORMAL (NOT DISSIMILAR TO GOULD'S PUNCTUATED EVOLUTION OF SPECIES)

- (4) MODELS WITH VARIABLES OF SOIL pH, SEA, $[O_2]$ CAN BE MAINTAINED IN NARROW RANGE

BY SIMILAR HOMEOSTATIC PROCESS

- (5) FUTURE STEPS USING MORE AND MORE REALISTIC EARTH VARIABLES: $\text{CO}_2\text{-O}_2\text{-H}_2\text{O}$, WEATHERING RATE AS $f(T)$; ETC.

i.e. MODELS OF ACTIVE FEEDBACK TO PREDICT INSTABILITIES AS SYSTEM NEARS LIMIT OF CAPACITY TO REGULATE (e.g. CO_2 -GLACIERS)

- (6) FOR LOVELOCK, DAISYWORLD MODELS CLARIFY THE DISTINCTION BETWEEN GEOPHYSIOLOGY AND THEORETICAL ECOLOGY. CLASSIC ECOLOGY MODELS, HE ARGUES IN AGES OF GAIA ONLY INVESTIGATED THE INTERDEPENDENCY OF SPECIES, SUCH AS FOXES AND RABBITS, NOT TAKING INTO ACCOUNT THE ROLE OF THE ENVIRONMENT. SUCH MODELS TYPICALLY REVEALED ANOMALOUS INSTABILITIES, SUCH AS THE APPARENT FRAGILITY OF COMPLEX ECOSYSTEMS (THE MORE COMPLEX THE MODELS'S VARIABLES, THE MORE READILY THE MODEL DESTABILIZED. REAL ECOSYSTEMS SUCH AS TROPICAL RAIN FORESTS REVEALED AN ANNOYING TENDENCY TO PERSIST IN THE FACE OF THIS THEORY. DAISYWORLD, ON THE OTHER HAND, BY COUPLING THE BIOTA WITH THE ENVIRONMENT,

PREDICTS THAT DIVERSITY OF LIFE WILL INDEED STABILIZE THE SYSTEM. TO LOVELOCK, CLASSICAL MODELS OF ECOLOGY, AS WELL AS THOSE FOUND IN GEOCHEMISTRY, ARE INHERENTLY INCOMPLETE, SINCE THEY LACK THE FUNDAMENTAL (~~REAL-WORLD~~) INTER-CONNECTIONS HYPOTHESIZED IN THE GAIA MODEL.

2. THE REAL EARTH: THE PLANKTON CONNECTION (4/87)
DISCOVERY OF POSSIBLE CLIMATE REGULATION BY PLANKTON

- Fig. 7
- a. PLANKTON PRODUCE DI-METHYL SULFIDE (DMS) (ACTUALLY OTHER WASTE PRODUCTS TOO) AS PART OF NORMAL METABOLIC EXCRETION
 - b. DMS DIFFUSES FROM SEAWATER TO ATMOSPHERE
 - c. DMS IN ATMOSPHERE OXIDIZES TO FORM SULFATE PARTICLES
 - d. KEY IS SULFATE PARTICLES ACT AS NUCLEI ON WHICH WATER VAPOR CAN CONDENSE; THEREFORE FORMING CLOUDS
- (1) 9/87: EXPERIMENTS CONFIRMED LINK BETWEEN DMS CONCENTRATIONS AND NUMBER OF CLOUD NUCLEI
 - (2) SATELLITE IMAGERY SHOWED SHIP'S EXHAUST LEFT LONG HIGHLY REFLECTIVE TRAILS IN MARINE CLOUDS: INCREASE IN CLOUD NUCLEI

LED TO INCREASE IN ALBEDO (REFLECTIVITY)

- (3) 30% INCREASE IN NUCLEI LEADS TO 1.3°K DROP IN TEMP GLOBALLY (4°K PRODUCED ICE AGE) i.e. PHYTOPLANKTON CAN CHANGE EARTH'S TEMPERATURE!

e. SPECULATION TO CLOSE GAIAN LOOP

- (1) TEMPERATURE DROP WOULD KILL PLANKTON
- (2) LESS PLANKTON MEANS LESS DMS; THEN LESS NUCLEI, LESS REFLECTIVE CLOUDS
- (3) TEMPERATURE WOULD RISE
- (4) UNKNOWN IS EFFECT OF TEMPERATURE ON PLANKTON POPULATION; ROLE OF CO₂ (LESS PLANKTON MEANS MORE CO₂ IN AIR, THEREFORE EARTH WARMS)

f. NONETHELESS - PLANKTON ARE LEADING CANDIDATE FOR GAIAN SYSTEM

3. AGU CHAPMAN CONFERENCE 1988

- a. GATHERING OF SCIENTISTS DOING RESEARCH ON GAIA
- b. PRIMARILY EXAMINING CYCLES IN CARBON, OXYGEN, SULFUR AND OTHER ATMOSPHERIC GASES, OCEAN SALINITY, FIRE; KEY ROLE OF BACTERIA (DIVERSE, RAPID GROWTH, RESPONSE W/ T, pH...) MARGULIS' HUMANS AS CLUMPS OF BACTERIA!

SELECTED TITLES

- (1) BIOLOGICAL MECHANISMS FOR GLOBAL CO₂ AND

F19 8

Relation of wooden
dipsticks to develop
deserts in US breadbasket
(on eating at Wendy's)

c.

TEMPERATURE REGULATION

- (2) ROLE OF PERIODIC CATASTROPHES IN TERRESTRIAL HOMEOSTASIS
- (3) TERRESTRIAL PHOTOSYNTHESIS, FIRE AND REGULATION OF ATMOSPHERIC O_2 (21% ACCIDENT (?) x 25% FIRE)
- (4) BACTERIA PRODUCED ATMOSPHERIC CONDENSATION AND ICE NUCLEI OR BACTERIA MAY INITIATE THE RAIN FOR THE PLANTS THEY LIVE ON

d. POINT: GAIA IS ACTIVE SCIENCE ; *NOT MAINSTREAM*

- (1) FIRE: NET O_2 PRODUCER : *Yellowstone-1988*
- (2) LAGOONS, CONT^{IN}TENTAL MARGINS: SINK TO REDUCE SALINITY (*LIFE TOLERABLE x 80m.y*)
- (3) C3 TO C4 METABOLISM (BROADLEAF TREE TO SOME GRASSES) AS RESPONSE TO GREENHOUSE (SURVIVE IN LOWER CO_2)
- (4) PLATE TECTONICS: Ca (TOXIC) COMBINED WITH CO_3 , SINK FROM SYSTEM AS LIMESTONE, INSULATION PERMITS POINT OF INVERSION FROM BASALT TO ECLOGITE TO RISE CREATING THIN PLATES PERMITTING P.T. TO WORK!?

*GSA '88
5 sum talks*

e. RELATION TO TRADITIONAL SCIENCE: INTERDISCIPLINARY, INTERCONNECTED

- (1) PROBLEM WITH CLASSIC ECOLOGY (ABOVE)
- (2) PROBLEM WITH CLASSIC INORGANIC CYCLES

(i.e. CO₂)

PREDICT TOO HIGH A LEVEL OF MODERN CO₂
IF ASSUME SUFFICIENT PRESENCE IN
PRECAMBRIAN TO NOT NEED GAIA; GAIAN VIEW
PREDICTS CORRECTLY

(3) NEED TIGHTLY COUPLED VIEW OF GAIA

D. KEY PERSPECTIVES ON GAIA

1. THE EARTH IS VIEWED AS A LIVING SYSTEM RATHER THAN AS A MACHINE. ASK QUESTIONS ABOUT HEALING RATHER THAN SPARE PARTS OR MECHANISMS. HISTORIANS OF SCIENCE HAVE REMINDED US THAT THE EXPERIMENTAL METHOD WAS ORIGINALLY DEVELOPED WITH THIS GAIAN VIEW, BUT THAT A FLEDGLING SCIENCE MAY HAVE BEEN FORCED TO ADOPT A MECHANICAL CLOCKWORK VIEW WITH ITS IMPLICATION OF A CREATOR TO APPEASE THE RELIGIO-POLITICAL POWERS OF THE TIMES.
2. HUMANS ARE VIEWED AS BELONGING TO AND EMBEDDED WITHIN THE NATURAL WORLD RATHER THAN AS SEPARATE 'OBJECTIVE' OBSERVERS OR EVEN PILOTS OF A SPACESHIP.
3. NATURE IS NOT SOMETHING TO BE CONTROLLED OR DOMINATED, BUT TO BE CARED ABOUT AND WORKED WITH (GEOPHYSIOLOGY). EMPATHY IS DESIRED ATTITUDE OF SCIENTISTS.
4. EMPHASIS IS ON COMPLEX, INTERACTING SYSTEMS (PERHAPS REQUIRING COMPUTER CAPABILITIES WE ARE

JUST BEGINNING TO IMAGINE) RATHER THAN ON LINEAR, REDUCTIONIST, SIMPLISTIC-DICHOTOMY REASONING. THE LATTER APPROACH BROUGHT US A GREAT DEAL OF UNDERSTANDING, BUT BASIC CAUSE-EFFECT REASONING IS, ACCORDING TO LOVELOCK, INADEQUATE TO DEAL WITH GLOBAL SYSTEMS. PERHAPS WE ARE SIMPLY MATURING IN OUR SEARCH FOR KNOWLEDGE.

- * 5. THE GAIA HYPOTHESIS COULD PRODUCE A REVOLUTION IN SCIENCE OF A MAGNITUDE COMPARABLE TO THE SWITCH FROM PTOLEMY TO COPERINICAN PARADIGMS. COPENICUS MOVED US AWAY FROM A GEOCENTRIC PERSPECTIVE; GAIA MOVES US AWAY FROM ANTHROPOCENTRIC PERSPECTIVES.
- 6. MY LIMITED EXPERIENCE WITH TEACHING GAIA SUGGESTS THAT TREATING NATURE NATURALLY RATHER THAN AS A TINKER TOY COULD LEAD TO A MAJOR RESURGENCE OF INTEREST IN THE SCIENCES.

III. CHALLENGING SCIENTIFIC PERSPECTIVES

A. ARGUMENT THUS FAR

- 1. GAIA HYPOTHESIS EXEMPLIFIES THE POSSIBILITY OF PARADIGM DEVELOPMENT IN SCIENCE
- 2. PHILOSOPHICAL CRITICISMS FROM OUTSIDE THE SCIENCES (FEMINISM) CONTRIBUTE TO OUR UNDERSTANDING OF NATURAL WORLD
- 3. NEED IS TO USE REASONING AND LOGIC DEVELOPED IN SUCH PHILOSOPHICAL ARGUMENTS TO DETERMINE

DIRECTIONS IN SCIENTIFIC RESEARCH - LET'S FIND OUT THINGS ABOUT THE NATURAL WORLD WHICH WE REALLY WANT TO KNOW IN A WAY IN WHICH WE WANT TO LEARN

B. LIBERAL ARTS ASSISTANCE TO GAIA. ONE POSSIBLE SOURCE OF ASSISTANCE IN SCIENCE (FEMINISM-PLUS) COMES IN A TRINITY: FEMINIST CRITIQUES, DEEP ECOLOGY, ECOFEMINISM

1. FEMINIST CRITIQUES OF SCIENCE - REVIEWED IN EXTENSIVE LITERATURE: KEY POINTS

- a. GOOD WOMEN'S STUDIES PROGRAM IS ESSENTIAL TO THIS SCIENCE PERSPECTIVE - *Else Gaia^(reg) turns into machine mentalit*
- b. BASIC OBJECTIONS OF FEMINISM
 - (1) ANTHRO (ANDRO-) CENTRISM (MAN AS NORM-SHOULD BE BACTERIA)
 - (2) HIERARCHICAL THINKING: MAN ABOVE NATURE (DARWIN'S EVOLUTION)
 - (3) DUALISTIC THINKING (MIND x BODY)
 - (4) SEPARATION OF SELF FROM OTHERS; NON-CONNECTED VIEWS (IDEA OF SCIENTIFIC OBJECTIVITY) [ATOMIC SCIENTISTS AS BOYS WHO LET MOM PICK UP SOCKS]
 - (5) COMPETITION/CONFLICT AS NORM RATHER THAN SIGN OF INSTABILITY (ROLE OF SYMBIOSIS IN SPECIES SURVIVAL; ARM-WRESTLING GAME)
 - (6) ALL ARE IDEAS PREVENTING US FROM SEEKING A DEEPER RAPPORT WITH NATURE.

Descartes separation of mind is religious-based assumption w/o empirical basis.

c. SUGGESTIONS FOR CHANGING SCIENCE PERSPECTIVES

- (1) LANGUAGE CHANGE (BACON, FEYNMAN)
- (2) SEEK MORE COMPLETE MATERIALISM BY TRANSCENDING DICHOTOMIES - NOT WORSHIP/ACCEPT THEM
- (3) SCIENTIFIC VALIDITY OF SUBJECTIVE
- (a) NO RIGID OBSERVER-OBSERVED BOUNDARIES
- (b) PARTICIPATE IN THE PROCESS
- (c) EXAMINE ETHICAL RELATIONSHIP TO RESEARCH
- (d) DYNAMIC OBJECTIVITY OF KELLER
- (4) VIEW NATURE AS ACTIVE (NOT PASSIVE) DYNAMIC COMPLEX; TOTALITY INCLUDING HUMANS; RESPECT FOR NATURAL BALANCE x MANIPULATE/CONTROL DEAD MACHINE
- (5) ELIMINATE RESEARCH THAT IS EXPLOITATIVE OR DESTRUCTIVE OF NATURAL WORLD
- (6) EMPHASIS ON HOLISM, HARMONY, COMPLEXITY SCIENCE PURSUED WITHIN THE DANCE OF LIFE (NATIVE AMERICAN; ~~CHINESE~~ ^{EASTERN} MEDICINES) ^{Shaw?}

Bacon
 - only has until I learn her secret
 - create biased race heros compares
 + subtle nature, shake her to her
 foundations, storm + occupy her culture
 will not mind subjectivity

Feynman
 said a little full in love at woman,
 his theory was good mother no
 longer attractive
Solow (1957) Nobel
 winning by taking 10 natural resources

Power Over (subdue)
 x Ability

Loving Nature x Name if
 claim if
 use it
 use it up

2. DEEP ECOLOGY: SESSIONS, DUVALL FOLLOWING SPINOZA'S PANTHEISM

- a. ECOLOGICAL CONSCIOUSNESS IS HUMAN CONSCIENCE
- b. ASK QUESTIONS OF VALUE ABOUT ECOLOGY - SEEK HARMONY/BALANCE IN NATURE

(1) NORM OF SELF-REALIZATION (NOT ISOLATED EGO)

(2) NORM OF BIOCENTRIC EQUALITY

3. ECOFEMINISM: FROM D'EAUBONNE (1974) AS ECOLOGICAL REVOLUTION WHICH WOULD CHANGE MALE-FEMALE RELATIONSHIPS (AND WINTER '87 CONFERENCE)

a. DISTINGUISH FROM SOCIAL/LIBERAL FEMINISM WITH ITS NON-ANTHROPOCENTRIC ORIENTATION

*choose culture
over nature
(like men)*

b. DISTINGUISH FROM RADICAL FEMINISTS BY EXTENDING THEIR EMPHASIS ON DOMINATION IN M/F RELATIONS TO THE NATURAL WORLD (i.e. OUTGROWTH)

c. KEY ISSUE IS ATTITUDE TOWARDS NATURE

(1) SEEK DIALECTICAL WITH NATURE AS PARTNER: RESTORED, ALIVE, ACTIVE; SPIRITUAL CONNECTION AS STARTING POINT

(2) CELEBRATE PERCEIVED CONNECTION OF WOMAN-NATURE. FEMALES AS BEST SCIENTISTS OF GAIA (EMPATHY, CONNECTED, DEEPER UNDERSTANDING ...)

(3) VALUE NATURE (AND DIVERSITY) FOR ITS OWN SAKE; NOT FOR HUMAN CONSUMPTION/CONSERVATION

(4) TURN TO THIRD WORLD, NATIVE AMERICANS FOR PERSPECTIVE/INSPIRATION

(5) KING: RATIONAL RE-ENCHANTMENT

4. ABOVE REPRESENT ONE BLEND OF EARTH PHILOSOPHIES FROM WHICH TO DEVELOP KEENER AWARENESS OF SCIENTIFIC PERSPECTIVES - DEEP SCIENCE

C. OTHER SOURCES

1. THEME OF NON-VIOLENCE AND VIOLENCE IN SCIENCE (THEMATIC MINOR)
 - a. RESONATES WITH ABOVE
 - b. RELATIONSHIP OF PEOPLE WITH PEOPLE ALSO APPLIES TO PEOPLE'S ATTITUDES TOWARDS NATURE
 - c. AIKI EXAMPLES (SHINTO/MARTIAL ARTS)
 - (1) CENTER
 - (2) KI/CONNECTION
2. POSSIBILITY OF LOOKING AT EASTERN AND THIRD WORLD APPROACHES TO KNOWLEDGE, PARTICULARLY MEDICINE (SHAWN: LYSTIGIUM ROOT)
3. LITERATURE: ESPECIALLY WOMEN AUTHORS IN SCIENCE FICTION WHO IMAGINE 'GAIAN' SCIENCE.
 - a. EMPHASIS ON ECOLOGICAL BALANCE, AWARENESS OF CYCLES WASTE DISPOSAL, SLOWER TECHNOLOGIES
 - b. NO MALE HERO GOES TO BATHROOM
4. ANALYSES OF HISTORY AND PHILOSOPHY OF SCIENCE
 - a. REVIEWS SUCH AS KELLER'S OF ORIGINAL FOUNDERS ATTITUDES TOWARDS NATURE
 - (1) ALCHEMISTS DEVELOPED EXPERIMENTAL METHOD CLOSE RELATIONSHIP TO GAIA
 - (2) CHURCH ROLE IN SUPPORTING MECHANISTS

*Staying Alive
Shiva*

(3) MYTH OF OBJECTIVITY

D. CLASSROOM POSSIBILITIES

1. TESTS/PROJECTS

a. RE-EXAMINE GLOBAL ISSUES WITH BOTH MECHANISTIC AND GAIAN PERSPECTIVES. GET STUDENTS TO PROPOSE ALTERNATIVE QUESTIONS AND SOLUTIONS TO ISSUES

b. FINAL EXAM

(1) NOT RECITATION OF ROCK IDENTIFICATION

(2) WHERE YOU AT - AWARENESS FROM DEEP ECOLOGY - IDEAS THAT WILL MATTER WHEREVER STUDENT LIVES

2. LIBERAL ARTS REQUIREMENTS

a. IS SCIENCE DISTRIBUTION MERELY A HANDS-ON OR DATA ACQUISITION EXPERIENCE? CURRENT APPROACH HAS NOT WORKED

b. SHOULD IT INCLUDE AN ANALYSIS OF THE NATURE AND ROLE OF SCIENCE IN OUR SOCIETY?

c. DOZEN LAS INQUIRIES, 10 FEMALE x 1 EVERY TWO/THREE YEARS

IV. CONCLUSIONS

A. SCIENCE, IN LIGHT OF FAILURE OF LOGICAL POSITIVISTS; OF EXAMINATIONS BY KUHN, SCHEFFLER, ETC. ATTACKING OBJECTIVITY; OF FEMINIST CRITIQUES OF SCIENCE; OF

4. NEED WORLD VIEW WHICH IS NOT ANTHROPOCENTRIC
 - a. VIEW NOT FRAGMENTARY
 - b. GRIFFIN: LOGICAL CONCLUSION TO BLOW UP WORLD
MAKE REALITY FIT THEORY
5. DEEP ECOLOGY SEEKS TO GO BEYOND KNOWLEDGE TO
ASKING QUESTIONS OF VALUE; DEEP SCIENCE NEEDS TO
DO THE SAME
 - a. VALUE, RELATIONSHIP TO NATURAL WORLD : *NOT JUST TOURISTS*
 - b. ROOTS - START WITH CONNECTION TO ACHIEVE A
DEEPER UNDERSTANDING : *SCIENCE FOR LIFE*
NOT JUST FOR MEN
(narrow sense)
ULTIMATELY ALSO FOR HUMAN
6. STARHAWK'S POEM:

c. "FINAL CENTURY"