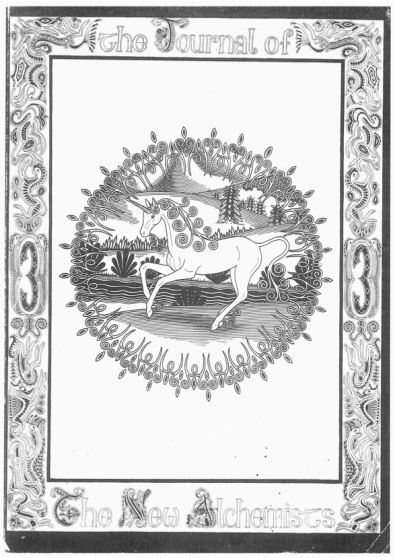
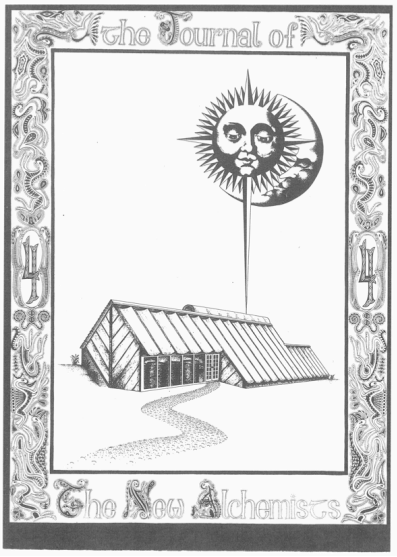
The Journal of

The New Alchemists

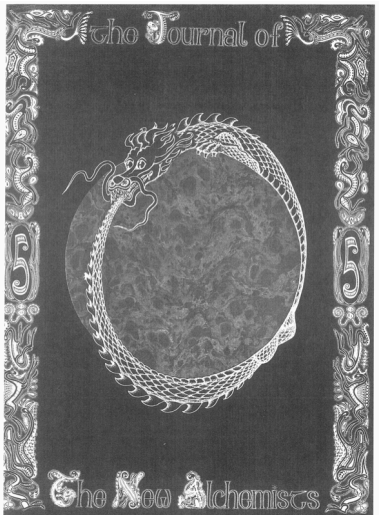


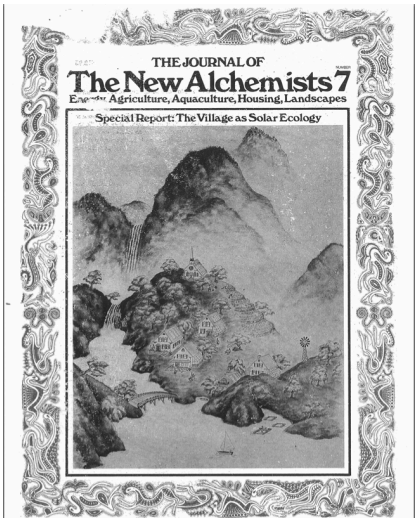
Journal of the New Alchemists



Journal 1 - 1973
Journal 2 - 1974
Journal 3 - 1976
Journal 4 - 1977
Journal 5 - 1979
Journal 6 - 1980
Journal 7 – 1981

To Restore the Lands,
Protect the Seas,
And Inform the Earth's Stewards





And Inform the Earth's Stewards

In addition to the seven Journals of the New Alchemists, the activities and research of New Alchemy were published in Research Reports, Technical Bulletins, Working Papers, Quarterlies (1980-1990), Progress Reports on Solar Aquaculture, books, posters, films, and articles in media. This information embodies the design-DNA that will enable the creation of ecologically-derived human support systems to direct the course of humankind towards a greener, saner world.

EB

SOLAR AQUACULTURE : Perspectives in Renewable, Resource-Based Fish Production
A Report to the National Science Foundation (151 pp.) September 1981.
[this is a final report summarizing all research & computer modelling of solar pond aquaculture up to June, 1982]

Ron Zweig (co-principal investigator)	Robert Angevine (administrative officer)
John Todd (co-principal investigator)	Albert Doolittle (computer monitoring speciallist)
John Wolfe (ecosystem analyst)	David Engstrom (water chemist)

Six progress reports were written as background to the above final report :
"Assessment of a Semi-Closed, Renewable Resource-Based Aquaculture System"
Progress Report No. 1 "A Six-Month Progress Report " May 23, 1978 88 pp. by John Todd & Ron Zweig
Progress Report No. 2 [not found]
Progress Report No. 3 – May 20, 1979 . 134 pp. (experiments from April 1978 to April 1979)
+ 14 appendices re: solar pond aquaculture, including :
I Instrumenting the Arks. by Albert Doolittle & Charles Rockwell.
II. Looking for a New Aquaculture : The Roads Ahead. by John Todd
IX Agriculture & Aquaculture in Bioshelters : The New Alchemy Experience. by John Todd & John Wolfe.
X The Energetics of Solar Pond Aquaculture. by John Wolfe
Progress Report No. 4 – December 7, 1979 (experiments from May 1979 to Sept 1979)
Progress Report No. 5 - September 22, 1980
Progress Report No. 6 - Part 1 Experimental Data - June 30-1982
Progress Report No. 6 - Part 2 Computer Simulation Model September 1981

ESEARCH REPORTS: [1979 - 1995]

RESEARCH REPORT 1. An Economic Comparison of Four 10,000-Square-Foot Food-Producing Greenhouses for Cape Cod, Massachussets. April 1986. 19 pp. by Norm Marshall

RESEARCH REPORT 2. An Analysis of Costs and Returns in Conventional and Organic Vegetable Production. July 1986. 16 pp. by Kurt Teichert

RESEARCH REPORT 3. The Composting Greenhouse at New Alchemy Institute: A Report on Two Years of Operation and Monitoring. Nov 1986. 30 pp. by Bruce Fulford.

RESEARCH REPORT 4. (not found)

RESEARCH REPORT 5. The Potential for Commercial Food-Producing Greenhouses in the Northeast : A Review of the Literature. March 1987. 19 pp. By Norm Marshall.

RESEARCH REPORT 6. Report on a Survey of New England Organic Farms. June 1987. 22 pp. by Kurt Teichert & Debra Schulz.

RESEARCH REPORT 7.. Laboratory and Field Application of Entomologenous Nematodes for Control of Insect Pest Species- Part One - Literature review. 1986. 19 pp. by Dave Simser.

RESEARCH REPORT 8. Lab and Field Trials 1987: Nematodes

RESEARCH REPORT 9. Lab and Field Trials 1989: Nematodes

RESEARCH REPORT 10. Cover Cropping and Green Manuring on Small Farms in New England and New York - An Informal Survey. July 1988. 27 pp. Mark Schonbeck.

RESEARCH REPORT 11. Bigflower Vetch and Rye vs. Rye Alone as a Cover Crop for No-till Sweet Corn. 1995 12 pp. by Ralph DeGregorio, Mark Schonbeck, Joshua Levine, Guillermo Iranzo-Berrocal, and Heidi Hopkins. (as published in J. of Sustainable Agriculture. Vol. 5(4) 1995)

RESEARCH REPORT 12 A Preliminary Experiment on Covering Sweet Corn with Netting to Exclude Raccoon. 1995. by Ralph DeGregorio, Mark Schonbeck , Dave Simser, Susan Cady, et al. J. of Sustainable Agriculture. Vol. 6(2/3) 1995. p 21-28.

RESEARCH REPORT 13 Winter Annual cover Crops for the Home Garden. 1995. by Mark Schonbeck , Ralph DeGregorio, & Peggy Elder. J. of Sustainable Agriculture. vol 6(2/3) 1995. p. 29-53.

RESEARCH REPORT 14 Evaluation of a Paper Mulch Made from Recycled Materials as an Alternative to Plastic Film Mulch for Vegetables. 1995. by Mark Schonbeck , Ralph DeGregorio, et al. J. of Sustainable Agriculture. Vol. 7(1) 1995.p 39-61.

MISC. RESEARCH REPORTS :

MISC RESEARCH REPORT 1 : Observations of Plant Response and Food Production in Solar Bioshelters. November 1977. 14 pp.
by Kathi Ryan & Earle Barnhart [report on maiden winter of Cape Cod Ark, built in fall 1976]
MISC. RESEARCH REPORT 2 Importance of Carbon Dioxide in Greenhouse Crop Production : A Greenhouse CO2 Dynamics Primer.
Nov 1 1978. 35 pp. by Robert "Sardo" Sardinsky
MISC. RESEARCH REPORT 3. Greenhouse CO2 Dynamics and Composting in a Solar Heated Bioshelter. 1979. 19 pp.
by Robert "Sardo" Sardinsky.
Published in " Solar Greenhouses : Living & Growing" - Proceedings of 2nd Natl
Energy-Conserving Greenhouse Conference. p 22-40. Am. Solar Energy Society.
MISC RESEARCH REPORT 4: A Design Report on The Bioshelter Exhibit for the Boston Museum of Science. April 1983
by Earle Barnhart & Peter Burgoon
MISC RESEARCH REPORT 5: The New Alchemy House : An Example of Sustainable Design"
by John Quinney and Donald Watson

TECHNICAL BULLETINS :

1. How to Build the New Alchemy Sailwing Windmill by Gary Hirshberg, Jay Baldwin, Joe Seale. 8 pp.
2. How To Construct a Solar Algae Pond. by Carl Baum and Ron Zweig. 4 pp.
3. Notes on Greenhouse Agricultural Management. by Colleen Armstrong. 8 pp.
4. The New Alchemy Institute Bibliography. 8 pp.
5. Designing Sustainable Small Farms & Homesteads. by John Quinney 12 pp.
(a reprint from Mother Earth News July/August 1984)
6. Home-Scale Wastewater Treatment Systems. by Tad Montgomery. 23 pp.
7. Controlling Aphids in the Greenhouse. 9 pp. Colleen Armstrong, Steven Chamay, Richard Heiman, Canstance Wiseman
8. Nontoxic Insect Pest Management for the Garden. 23 pp. Pam Moran and Dave Simser.
9. Toxins In the Home and Safe Alternatives. 22 pp. Maureen Mc Clelland
10. Gypsy Moth Control

QUARTERLIES : [1980 - 1990]

New Alchemy Quarterly : [plus selected articles]

1. Spring 1980. Notes on Tree Crops at New Alchemy. 8 pp.
2. Summer 1980..
3. Fall 1980. 8 pp.
4. Winter Solstice 1980. - Notes on Greenhouse Agricultural Management. by Colleen Armstrong. 12 pp.
5. Summer 1981.. 16 pp.
   -- Gardening in Fertile Waters by Carl Baum
6. Fall 1981. 24 pp.
   -- Bioshelters - Pillowdomery by J. Baldwin
7. Winter 1981/1982. 24 pp.
   -- Bioshelter . by John Wolfe
   -- Relative Insulating Properties of Gases. by Joe Seale
8. Spring 1982: Reading Up, Reaching Out. 24 pp.
   -- Costa Rica : A Report from N.A.I.S.A. by Wm. McLarney
   -- Aquaculture - Hydroponics in the Ark. by Peter Burgoon
9. Summer 1982 Second Generation Bioshelters 24 pp.
   -- Tefzel
   -- The Pillow Dome Opening : The Modern Age of Bioshelters Begins. by Gary Hirshberg
   -- The Latest Year of Research on Bioshelters : A Summary. by John Wolfe
   -- [Fish] Breeding in Bioshelters. by Linda Gusman
   -- Bioshelters : How's the Dome Project doing? by J. Baldwin
   -- Heat Transfer with Insulating Gases. 12 pp. by Joe Seale
10. 1982 . Annual Report
11. Spring 1983. 24 pp.
   -- Farming Black Locust and Bamboo on Cape Cod. by Earle Barnhart
   -- Notes from the Winter Dome. by Daryl Bergquist
12. Summer 1983: 24 pp.
13. Fall 1983: Naives and Visionaries 20 pp.
   -- Overall, the Pillow Dome is working well. by Daryl Bergquist

14. Winter 1983: 24 pp.
    -- The Composting Greenhouse for Commercial Regenerative Agriculture. by Bruce Fulford
    -- Some New Ideas for Residential Bioshelters. by Earle Barnhart
    -- Working to Breed a Better Predator. [greenhouse IPM] by Colleen Armstrong.
    -- How Warm are Our Bioshelters? by Daryl Bergquist.
    -- Seasonal Aquaculture : Outdoor Summer Production. by Ron Zweig & Linda Gussman
15: Spring 1984. 24 pp.
16. Summer 1984. Alternative Agriculture. 24 pp.
17. Fall 1984., 24 pp.
18. Winter 1984.. Do Integrated Systems Really Work Better? . 24 pp
    -- Business School Student Looks at NAI's Composting Greenhouse. by Norm Marshall.
    -- The Economics of Integration : The Composting Greenhouse as a Case Study. by Bruce Fulford.
    -- When Do Solar Algae Ponds Make Cents?. by Ron Zweig.
    -- Infared Radiation Heat Loss Through Greenhouse Glazings. by Daryl Bergquist.
19. Spring 1985: Growing Food in Water: The Art & Science of Aquaculture and Hydroponics. 24 pp.
    -- Why Aquaculture? by Wm. McLarney
    -- A Simple Demand Feeder for [Fish] Cage Culture. by John Hargreaves.
    -- The [Typical] New England Household. by David Rosenmiller & John Quinney.
    -- Evaluation of Biological Islands for Control of Greenhouse Whitefly. by Richard Meadows.
    -- The Compost [Greenhouse] Story Heats Up. by Bruce Fulford.
20. Summer 1985: Educating for the Future - Now. 24 pp.
21. Fall 1985: Beating the System. 24 pp.
    -- An Aphidoletes aphidimyza Update. by Colleen Armstrong
    -- The Economics of Food-Producing Greenhouses in the Northeastern United States. by Norm Marshall
22. Winter 1985: Some New Ideas on the House of Your Dreams. 24 pp.
    -- Our Superinsulated Auditorium : Monitoring Results summary. by Bill Smith.
23. Spring 1986: Designing The New Landscape . 24 pp.
    -- Lessons Learned from an Established Edible Landscape. by Earle Barnhart .
    -- Composting Greenhouse Update. by Bruce Fulford
24. Summer 1986: Alternative Technology Around the World. 24 pp.
25. Summer 1986: The Future of the Small Farm. 24 pp.
26. Winter 1986: We Design Our House. 24 pp.
    -- Hard Choices in Building Design [the New Alchemy House]

27. Spring 1987: Between the Pointed Stick and the Chisel plow : Small Farm Technology. 24 pp.
28. Summer 1987: Keeping Our Eyes On The Vision, Feet On The Ground. 24 pp.
29. Fall 1987: Solar Greenhouses. 24 pp.
    -- Composting Greenhouse Design Update. by Norm Marshall
    -- Refurbishing the Ark. by Mark Ward
    -- Nitrogen in the Composting Greenhouse by Mark Schonbeck.
30. Winter 1987 : Biological Controls: A Promising Future. 24 pp.
31. Spring 1988: Meeting the Affordable Housing Challenge. 24 pp.
32. Summer I988: Preserving Genetic Diversity. 24 pp.
33. Fall 1988: Composting and Cover Crops. 24 pp.
    -- Nitrate in Winter Greenhouse Leafy Vegetables. by Mark Schonbeck
34. Winter 1988 : Old Alchemists Write Home. 24 pp.
35. Spring 1989: Educating Tomorrow's Environmentalists'. 24 pp.
    -- New Alchemy's Green Classroom. by Judy Salisbury
    -- Ecosystems for the Classroom. by Earle Barnhart
36. Summer 1989: Managing Growth. 24 pp.
    -- Composting Greenhouse Update. by Mark Schonbeck.
37. Fall 1989 : Promise Rediscovered : New Alchemy's First Twenty Years. 24 pp.
    [an overview of New Alchemy from 1969 to 1989]
38. Winter 1989-90: Curcs, Legumes, Fruit Loops & More: Our Researchers' Latest Work. 24 pp.
    -- Growing Mulch in Place. by Mark Schonbeck & Ralph DeGregorio
39. Spring/Summer 1990 : A Message to Earthkeepers. 24 pp.
    -- The Future of Entomogenous Nematodes and the Modern Insect Pest. by Dave Simser
    -- Cover Crops at a Glance. by Mark Schoenbeck & Ralph DeGregorio
    -- Cutting Off the Nitrate Supply. by Robert Rivera, Mark Schonbeck & Ralph DeGregorio
        [nitrates in winter-grown greenhouses leafy vegetables]
40. Fall 1990 : New Alchemy in the '90's. 24 pp.
    -- Cover Crops for Weed Control in Lettuce. by Mark Schonbeck, Judy Browne, & Ralph DeGregorio.

NEW ALCHEMY BOOKS :

The Book of the New Alchemists, 1977. 176 pp. edited by Nancy Jack Todd. publ. E.P. Dutton, New York.

The Village As Solar Ecology, : Proceedings of the New Alchemy/Threshold Generic Design Conference of April 1979. 1980. 135 pp.
editors John Todd and Nancy Jack Todd.

Backyard Fish Farm Book,: Growing Fish in Floating Cages. ,1981. 90 pp.
William McLarney and Jeffrey Parkin Brickhouse Publishing Co.

A Guide to Home Food Production 1982. 176 pp. by staff of New Alchemy. publ by Cape & Islands Self-Reliance Corp A Teacher's

Water Pumping Windmill Book , 1982. 141 pp. by Gary Hirshberg. Brickhouse Publ. Gardening for All Seasons 1983. 309 pp. by staff of New Alchemy Institute. editors Gary Hirshberg and Tracy Calvan.
Brickhouse Publ.

Manual for the Green Classroom – A Garden Based Science Curriculum. Aug 1988. 166 pp. by Judith Salisbury.
publ by New Alchemy Institute

BOOKS BY NEW ALCHEMISTS – OTHER PUBLISHERS :

The Freshwater Aquaculture Book : A handbook for small scale fish culture in North America. 1984. by William McLarney. 583 pp
Cloudburst Press

Bioshelters, Ocean Arks, City Farming: Ecology as the Basis of Design 1984. by John and Nancy Todd

From Eco-cities to Living Machines 1994. by John and Nancy Todd

A Safe and Sustainable World : The Promise of Ecological Design 2005. by Nancy Jack Todd Island Press

WORKING PAPERS : [1983 - 1988]

1. The Pillow Dome Bioshelter : part I, data analysis. Joe Seale, Daryl Bergquist, and John Quinney. Fall 1983
2. The Pillow Dome Bioshelter : part 2 - test cell investigations. Daryl Bergquist and Joe Seale Spring 1984.
   (A final report to E.I. duPonde Nemours & Company, Inc.)
3. Biothermal Energy : cogenerants of thermophilic composting and their integration within food-producing
   and waste-recycling systems. Sept 1983. 19 pp. by Bruce Fulford.
   (reprinted from Proceedings of the First Intl Conf. of Composting of Solid Wastes& Slurries, Leeds England)
4. Year-round vegetable growing in Massachusetts : an economic comparison of a hydroponic greenhouse
   and a composting greenhouse. May 1984. by Rob Lichtman
5. Studies on the suitability of several sages and scented geraniums as host plants for greenhouse whitefly
   Trialeurodes vaporariorum Westwood and its parasite Encarsia formosa Gahan . Fall 1984. by Richard H. Meadows.
6. Integrated pest management in bioshelters : research and education. Dec. 1984. Colleen Armstrong and John Quinney
   (A final report to the Massachusetts Society for Promoting Agriculture)

7. Non-chemical pest control for year-round food production in cold climates : research and education. April 1986
   Colleen Armstrong and John Quinney. (A final report to the C.S. Fund)
8. Collaborative projects involving the egg-parasitic wasp, Edovum puttleri. December 1985. Bugg, R.L.
9. The use of nectar-bearing plants to enhance biological control of pests of collards. Jan 1986. Robert L. Bugg..
10. Insects visiting flowering herbs on Cape Cod, Massachusetts. Fall 1986. 64 pp. Hilde Maingay.
    (masters thesis, Antioch New England)
11. The New Alchemy Institute superinsulated auditorium : monitoring results - a low-cost computer monitoring system
    for superinsulated buildings. Fall 1985. Bill Smith, Daryl Bergquist, & Joe Seale
12. Relevant statistics on the life support systems of a typical family of four in New England. Jan 1985. 98 pp. David Rosenmiller
13. An economic analysis of home food production. April 1987. 143 pp. David Rosenmiller
14. Alternative technology demonstration houses. Spring 1986. Jake Sterling

15. The market for the residential bioshelter. Oct 1985. Norm Marshall
16. The thermal performance of the New Alchemy Institute's composting greenhouse. Jan 1987. 19 pp.
Daryl Bergquist, Bruce Fulford, Norm Marshall, and Rick Baruch.
17. Co-composting dairy manures and bulking agents from the solid waste stream. Jun 1987. 79 pp. Bruce Fulford.
18. Considerations for New Alchemy Institute's role in green manure research. Aug 1986. Lisa Colburn. 13 pp.
19. Nitrogen dynamics in the New Alchemy Institute's composting greenhouse. June 1987. 78 pp. Mark Schonbeck
20. Toxicity of selected pesticides to the aphid predator Aphidoletes aphidimyza. May 1987. Colleen Armstrong
21. IPM for food production in cold climates : pesticide tolerance of Aphidoletes aphidimyza. 1987. Colleen Armstrong
22. Leaf composting pilot projects in the Commonwealth of Massachusetts. Dec. 30, 1987. Bruce Fulford and John Quinney.
(report to Mass. Division of Solid Waste Management & Mass. Dept of Envir. Quality Engineering)
23. (not found)
24. (not found)
25. (not found)
26. Greenhouse vegetables, nitrates, and human health : a literature review. Dec. 1987. 39 pp. Mark W. Schonbeck
27. Toxins in the home. Sept. 1987. Maureen McClelland. 37 pp.
28. The classroom ecosystem. 1988. Earle Barnhart and Judith Salisbury 51 pp.
29. Improved composting greenhouse designs based on energy, nitrogen, and materials handling research. Dec 1987. 28 pp.
by Kurt Teichert, Mark Schonbeck, Bruce Fulford, Daryl Bergquist, Lee Goodell
30. Integrated pest management for greenhouse floriculture - chrysanthemums. 1988 . Colleen Armstrong

REPORTS ABOUT THE ARK ON PRINCE EDWARD ISLAND, CANADA
(the Ark on PEI was built by New Alchemy PEI in 1976, and operated by NAI PEI until 1978.
The PEI Canadian provincial government then managed it until June 1981.)

An Ark for Prince Edward Island : A Report to the Federal Government of Canada. Dec 30, 1976. Book 11" h x 22" wide. 78 pp.
By John Todd, Robert Angevine, Solsearch Architects, Tyrone Cashman.

POSTERS :
"THE ARK - an early exploration in weaving together the sun, wind, biology, and architecture on behalf of humanity"
by Solsearch Architects & New Alchemy Institute. 20"x28", 2 sides.
(Full color exterior photograph on one side, architects' drawing of the interior and how it works on the other side.)
"The P.E.I. Ark" by Solsearch Architects, Charlottetown, PEI, Canada. 22"x30"
"This poster updates the design description in the 'Journal of the New Alchemists (3). 1976."

FILM :

"The New Alchemists" 1974. National Film Board of Canada, Montreal. 16 mm. color 106C 0174 157 28 minutes 40 seconds.

"New Alchemy: A Rediscovery of Promise". 1984. by Lawrence Burke, Flying Cloud Moving Pictures. (54 minute or 27 minutes)
"A portrait of the people and place which make up the New Alchemy Institute, one of the world's pioneering appropriate technology research centers." Shows research and education about solar energy, ecology, aquaculture, organic farming and environmental design.

ARCHIVED PUBLICATIONS :
Additional records of the New Alchemy Institute are located at Iowa State University Library, Department of Special Collections, 403 Parks Library, Iowa State University, Ames, Iowa, 50011-2140.
(correspondence, minutes, publications, and other materials, from 1970-1991,

OTHER PUBLICATIONS BY NEW ALCHEMISTS :

Annals of Earth — Annals is a publication of Ocean Arks International. Edited by Nancy Todd, it describes on-going work by New Alchemists or related ideas about ecological sustainability.
Ocean Arks International, 176 Battery Street, 3rd Floor, Burlington, VT 05401

SELECTED MAGAZINE ARTICLES ABOUT NEW ALCHEMY in the mid-1970's:

"The New Alchemy : how to survive in your spare time" James K. Page Jr., and Wilson Clark. Smithsonian Magazine, February 1975.
"The New Alchemy Institute : Search for an Alternative Agriculture" Nicholas Wade. Science Vol. 187, No 4178, February 28, 1975.
"The New Alchemists" John Todd. The Co-Evolution Quarterly, Spring 1976.
"The New Alchemists" Wade Greene. The New York Times Magazine, August 8, 1976.
"The New Alchemists: Creating a Gentle Science to Heal the Earth". Michael Gery. New Roots for the Northeast Nov/Dec 1979. p. 20-26. Northeast Appropriate Technology Network, Greenfield, MA

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The Journal of

The New Alchemists

The New Alchemists

To Restore the Lands, Protect the Seas, And Inform the Earth's Stewards

The New Alchemy Institute is a small, international organization for research and education on behalf of man and the planet. We seek solutions that can be used by individuals or small groups who are trying to create a greener, kinder world. It is our belief that ecological and social transformations must take place at the lowest functional levels of society if mankind is to direct his course towards a saner tomorrow.

Among our major tasks is the creation of ecologically derived forms of energy, agriculture, aquaculture, housing and landscapes, that will permit a revitalization and repopulation of the countryside. The Institute has centers existing, or planned, for a wide range of climates in several countries, in order that our research and experience can be used by large numbers of people in diverse regions of the world.

The Institute is non-profit and tax-exempt, and derives its support from private contributions and research grants. Because we are concerned with ecological and social tools useful to small groups or individuals, many orthodox channels of support are not available. The success of the Institute will depend upon our ability to address ourselves to the genuine needs of people working on behalf of themselves and the earth, and to the realization by all our friends that financial support of our research is necessary if the task ahead is to be realized.

The New Alchemy Institute has an Associate Membership ($25.00 per annum, tax-deductible) which is available to anyone with an interest in our goals. Associate members receive our periodic publications which deal with theoretical and practical aspects of new world planning. Associates are also provided with information and guidance from New Alchemy Institute scientists and other individuals with relevant skills. Associate Membership can involve a close dialogue with the Institute, and Associates contribute their talents and work with us on problems of mutual interest.

ASSOCIATE MEMBERSHIP	*$25 per annum*
Contributions of large amounts are very much needed	
and, if you can afford more, that would be beautiful.	
SUSTAINING MEMBERSHIP:	*$100 or greater*
PATRONS OF THE INSTITUTE:	*$1,000 or greater*

We invite you to join us as members of The New Alchemy Institute. A company of individuals, addressing themselves to the future, can perhaps make a difference during these years when there is waning reason to have hope in the course of human history.

THE NEW ALCHEMY INSTITUTE
P. O. Box 432
Woods Hole, Massachusetts 02543 U. S. A.

CENTERS

WOODS HOLE, MASSACHUSETTS SANTA BARBARA, CALIFORNIA

PRICE PER COPY $4.00

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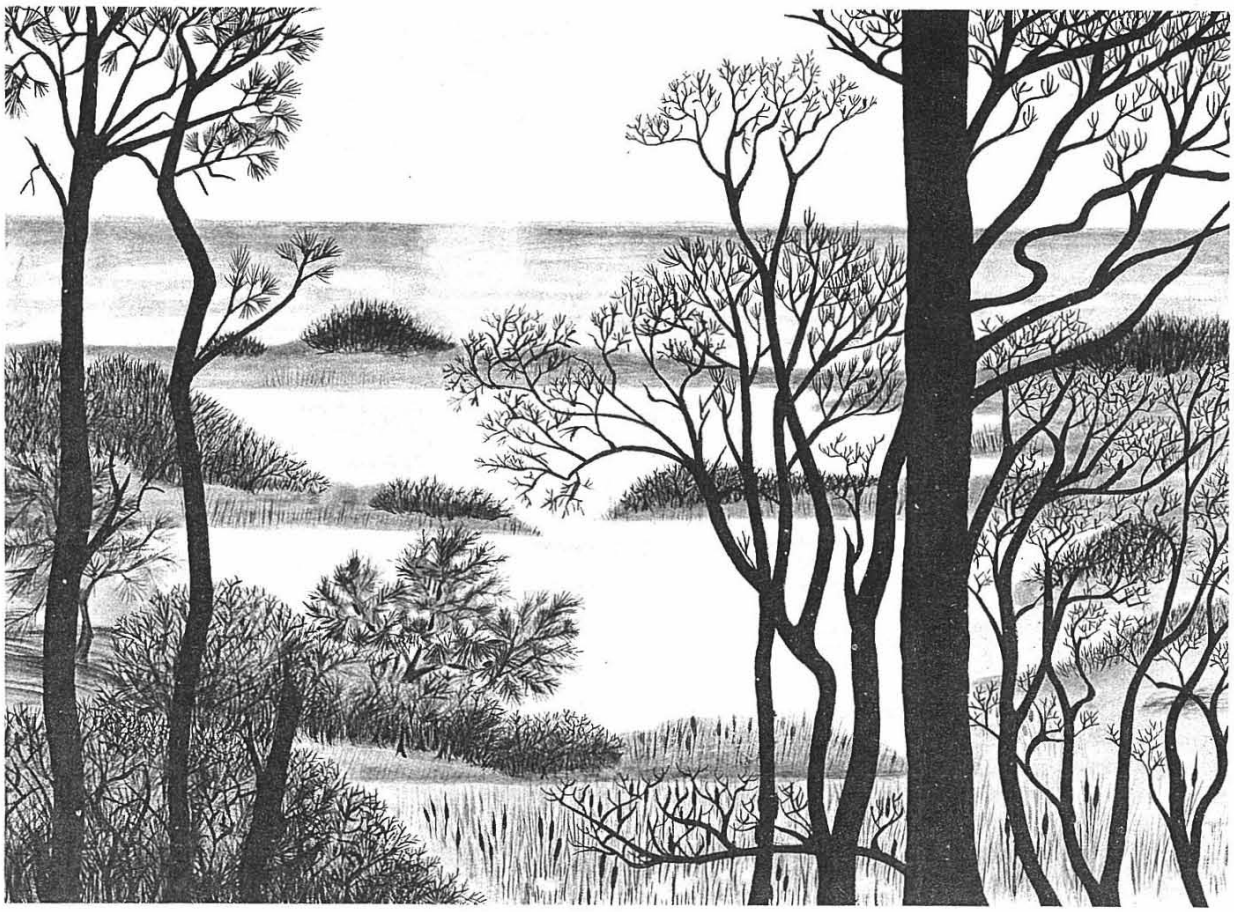
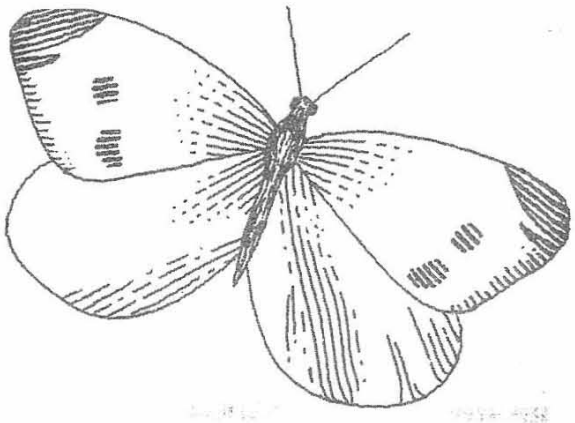
Now, my co-mates and brothers in exile,
Hath not old custom made this life more sweet
Than that of painted pomp? Are not these woods
More free from peril than the envious court?
Here feel we but the penalty of Adam,
The seasons' difference; as, the icy fang
And churlish chiding of the winter's wind,
Which, when it bites and blows upon my body,
Even till I shrink with cold, I smile and say,
'This is no flattery: these are counsellors
That feelingly persuade me what I am.'
Sweet are the uses of adversity
Which like the toad, ugly and venomous,
Wears yet a precious jewel in his head;
And this our life exempt from public haunt,
Finds tongues in trees, books in the running brooks,
Sermons in stones, and good in every thing.
I would not change it.

SHAKESPEARE
As You Like It

New Alchemy





With this first issue of **The Journal of the New Alchemists,** *we begin a new publishing format. Our early publications were called "Bulletins", but bulletin had a hard, almost militaristic ring and was a poor description of New Alchemy ideas. Newsletter was better, but what we want to say can hardly be defined as what is commonly understood as news. We cast about again and have, with some labor, given birth to this,* **The Journal of the New Alchemists.** *Echoing many voices, recording our research, reflecting broader experiences as we travel the world or as the world touches us, we plan with this expanded issue to share with our Associates and readers and friends as much of New Alchemy as can be transmitted onto paper.*

To do this we have divided the **Journal** *into five subsections:*

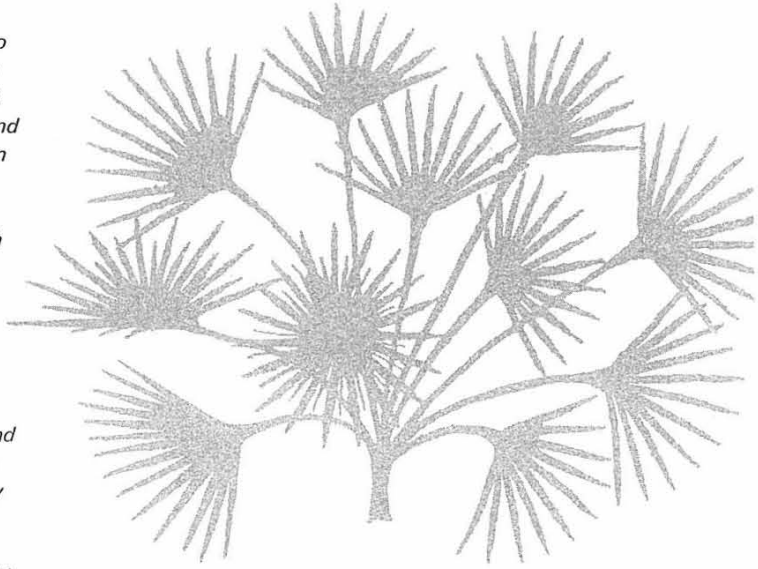
New Alchemy
Energy
Land and Its Use
Aquaculture
Explorations

The first four titles are largely self-explanatory. The first section on **New Alchemy** *will include news that springs directly from the work in which we are involved.* **Energy** *obviously will report on our efforts to harness the pure energy sources of the sun and the wind and to integrate captured energy into the aquacultural and agricultural systems. Recognizing that a healthy soil and careful stewardship are basic to all life,* **Land and Its Use** *will range over agricultural systems and the use and abuse of land. Under* **Aquaculture** *we shall report not only on the progress in our own fish ponds but also on systems both beginning and established elsewhere.* **Explorations** *will be exactly what the word suggests - a tentative reaching as much towards wisdom as towards harmonious and ecological ways of living although the one no doubt embraces the other. We hope that the sum of the parts will result in a* **Journal** *that combines a nuts and bolts approach with scientific and philosophical overtones.*

We are beginning to build bibliographies in several areas and these will appear from time to time. In this issue, in the **New Alchemy** *section we have included an annotated bibliography of writings by New Alchemists as well as bibliographies on hedgerows, companion planting, and land use in the tropics. In future* **Journals** *we plan to review books that we feel would be relevant for our readers, such as Peter Van Dresser's* **A Landscape for Humans.**

Bill McLarney's paper in the **Aquaculture** *section is the first, we hope, of many that although in the province of pure science could be applicable to the restorative type of knowledge we pursue. We should like readers who would like to contribute either scientific papers or articles on subjects that might be of interest to like-minded people to send them to us for possible publication. We hope to tie in themes that are as various as the possibility of drawing on the enormous potential energy of the women's movement and the application of ecological principles to urban as well as rural settings. We have many friends who have suggested exciting contributions and are eager for more.*

Even more important than the divisions that we have created is the underlying unity of the work and the ideas. The view we wish to share is wholistic rather than fragmented. The threat that western technology poses to peoples in very different climates and countries is traceable through Will Wroth's essay on Traditional Ways in New Mexican Villages, which is in **Explorations,** *and John Todd's observations on Costa Rica discussed under* **Land and Its Use.** *The destruction of traditional ways by the infiltration of our own plastic-fantastic system is a pattern of which we are all despairingly aware and yet there is still relevance in noting its course if we are either to learn anything from the last vestiges of simpler ways or to stem the tidal wave of western technocracy. One of our most recent visitors is excited by the possibilities of using in rural Canada the windmills Earle Barnhart discusses under* **Energy.** *In the same section Marcus Sherman reports on the building of the sister windmill to the one on the Cape Cod farm in Southern India. Bill McLarney's aquaculture was born in the orient. He would transplant the concepts to Costa Rica and to any other country where there is a need for an economical protein source. This is at once* **Aquaculture** *and* **Exploration.**



With words, diagrams and dreams, the first **Journal of the New Alchemists.**

Financial Status of the Institute

The past year has seen slow but important changes in the Institute's financial position. Our Associates, through their memberships, have helped underwrite the costs of the *Newsletters* and a portion of the expenses for the *Journal of The New Alchemists.* This help is very much appreciated and we hope the new *Journal* will gain more friends and Associates for the Institute.

Special thanks go to two foundations who have had confidence in our early attempts to shape a microcosmic science within a human framework. The Stern Family Fund supported our proposal "A Biotechnic Science for Ecologically-Derived Communities". The grant allowed us to pay a few salaries and purchase the equipment needed to conduct research at the Cape Cod center.

Stewart Brand and the Point Foundation came to our aid recently at a very critical time. The foundation provided us with the seed money to begin developing and researching the energetics and productivity of a model, prototype year-round aquaculture and vegetable food growing system suited to northern climates. The system which we have dubbed "The Earth Ship" will use no conventional sources of energy. A windmill will provide the necessary power, and the climate inside the growing structure will be maintained by polyculture fish ponds heated by a solar device. The Point Foundation grant will enable us to build and study a scale model.

The financial picture was dampened by the loss of support for our countrywide "People as Scientists Program". The money paid the rental on our present center and the salaries of the program coordinator and the head of the Institute's agricultural-ecology research. Apparently the loss of support was not a criticism of the fledgling program in which several hundred people were involved in researching Backyard Fish Farms, Insect Resistance in Vegetable Crops, and the efficacy of Ecological Design in Food Gardens. The sponsor, Rodale Press, was undergoing a fiscal belt-tightening necessitated by rising costs. The program will continue on a reduced, volunteer scale and a part-time salary for the program coordinator will come from the Point Foundation grant. We don't want to give the program up until it has borne fruit.

The coming months are going to be critical for the Institute and its centers on Cape Cod and at Santa Barbara. Both need to be put on a more solid monetary base. Towards these ends several new proposals have been prepared, or are in preparation, and we are now seeking sponsors.

1. New Alchemy West: AN INTEGRATED APPROACH TO SMALL SCALE, ALTERNATIVE ENGY: A PILOT MODEL USING SOLAR ENERGY DEVICES AND ORGANIC DIGESTERS.
   Principal: Richard Merrill - Budget - $27,495.

2. New Alchemy-East: A SOLAR AND WIND POWERED AQUACULTURE AND GREENHOUSE COMPLEX FOR NORTHERN CLIMATES.
   Principals: R. Angevine, E. Barnhart and J. Todd - In preparation

3. New Alchemy-International: THE DEVELOPMENT OF AN AQUACULTURE SYSTEM FOR THE AMERICAN TROPICS.
   Principal: William O. McLarney - Budget for four years at an annual cost of $32,600.

4. The New Alchemy Institute: THE JOURNAL OF THE NEW ALCHEMISTS: A NON PROFIT PUBLICATION FOR NEW WORLD PLANNING ON A HUMAN SCALE.
   Principal: Nancy Todd - In preparation. An additional support of $19,000 annually is needed to produce the JOURNAL on a quarterly basis. It will be made available for wide distribution.

Stewart Brand in one of the first editions of the Whole Earth Catalog quoted a saying of Dick Alpert "It's love money that underwrites this sort of venture every time".

He was referring, of course, to the Catalog, but we feel it applies in our own case. Without money and organization in front, the best intentions of a small group like ourselves, no matter how dedicated, will not flourish and reach outward into the community at large. We thank those of you who have helped us.

VISITORS

Many people write to us asking about the possibilities of visiting, spending time at the farm, even of working with us. It took us a bit of time to get over feeling rather surprised and pleased that anyone was taking an interest in us or finding our work relevant. We do basically still feel that way but have been forced to find some framework from which we can both relate to people and yet continue the work that drew them to us. In spite of our libertarian instincts, we have had to evolve a means of coping with much larger numbers of people physically as well as theoretically.

Our first idea dates back to last summer and must be credited to Rich Merrill. He suggested that we have something similar to an old-fashioned barn-raising. People were invited to join us working in the fields and in doing so to learn something about gardening organically. For a year, farm Saturdays, as they have come to be known, have become a tradition - working together, a great deal of talk and a feast at noon.

This is the day we prefer people to visit. We have abandoned for the day any projects that can't be interrupted. We'll be working but whatever it is, hauling seaweed from the beach, weeding, planting or building domes, we can always use more hands and heads. Please come then. Bring some food for the feast. If you want to visit New Alchemy, Saturdays are best.

This applies from May until November. For the rest of the year many of us are away and we are officially closed. That is, until we have marvelous eco-houses full of lettuces and ripening oranges as blizzards rage outside.

Frequently people planning to visit the farm are anxious about accommodation and here we have little help to offer. We have no space available at all in the house. The Falmouth City Fathers frown on unlicensed camping and we aren't allowed to let people put up tents. There is a camp ground nearby which may have some room. This is probably the best possibility for those who would like to spend several days in the area without paying astronomical rates for motels.

EMPLOYMENT OR APPRENTICING

We receive many requests from people to work, study or apprentice with us. Some are highly trained scientists and others are without skills but with a deep interest in learning how to care for the planet. Our answer to everyone has had to be the same. We are a relatively small group and at New Alchemy East, for example, where a lot of the overall administration of the Institute is carried on, we have developed a limited growth policy. There are two basic reasons why this is so: first, we haven't the financial resources to expand, and secondly, we want to limit our ultimate size to about thirty; a number that will allow us to work together and to know each other. In order for the Institute to grow, new centers will have to be established by New Alchemists who are drawn to other environments and climates.

Most importantly we are more concerned with the spread of the ideas of stewardship and the power of the biological and social microcosm for aiding men everywhere than we are with the growth of New Alchemy the organization.

People who are genuinely interested in working with us are welcome. However, we can provide no salaries or accommodation even for visitors who come for a brief stay. It is necessary for most newcomers to establish themselves in surrounding communities and work with us in their spare time. Most of us, including the original people, worked for years at other jobs before we were able to secure even partial support within NAI. If we were better endowed, new people could be incorporated faster, but our growth would still be slow.

Those who do come share with some of the administration and work with us building, taking measurements and caring for the gardens. The door is open to students for advanced studies or research at NAI if the above conditions are met.

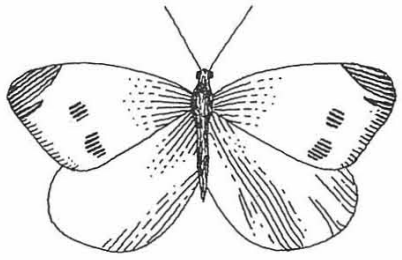
A NOTE TO ASSOCIATES

In a Journal in the near future we should like to publish a list of the names and addresses of our Associates. It might be useful for people to be able to contact others in their geographical area or to correspond on subjects of mutual interest. As this was being discussed a few cautious voices were raised saying that perhaps there might be Associates who would not want their names published. So we have compromised. If you are an Associate who would prefer to remain anonymous please let us know, and we shall, of course, respect your wish. For the rest, we expect to include the list in the second Journal. Perhaps, unknown to all of us there now are one or two embryonic communities waiting to be born.

CHANGING SEASONS

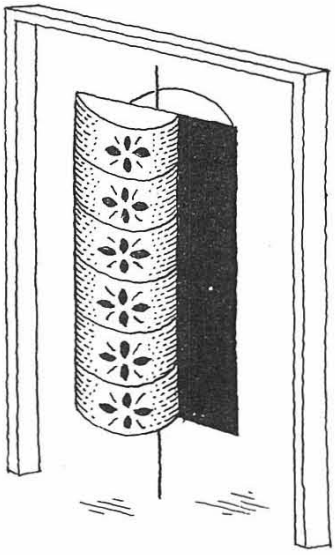
With the coming of winter the intensity of the activity on the New Alchemy farm, bound as it is to the song of the seasons, began to lessen. We continued planting trees, collecting leaves for compost, tuning the windmill, and feeding the tilapia, but cold rains and gusting winds made outside work much more rugged and even farm Saturday became more of a day when we met to do administrative work and correspondence, visit and have a good lunch. Christmas came and went. We mailed the Newsletters, and then leaving a small core with the Herculean task of keeping everything running, many of us set off in search of both warmer sun and other settings that might be in need of the ecological and restorative ideas of New Alchemy. Marc Sherman left for India. He tells of his work there in *Energy*. Some of the rest of us spent the winter in Costa Rica and discuss the results of that trip at some length in the section *Land and Its Use*.

The three left on the farm carried on intrepidly and still found the time to spin some lovely dreams. The crocus were in blossom when we came home.



WINTER

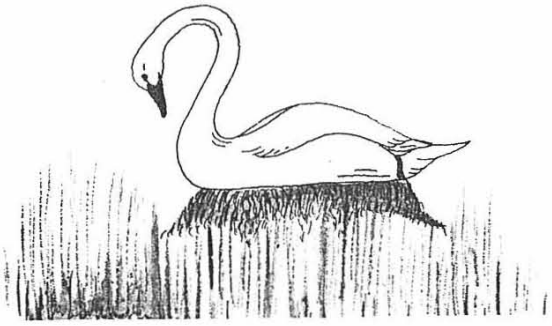
The winter on the Cape was a period of preparation rather than hibernation. The 1973 summer garden received much planning and forethought, resulting in a design that incorporates techniques of crop rotation, crop succession, inter-planting, and companion planting. Vegetables, crops and planting dates were chosen that would supply ample food over the whole summer and would also yield crops suitable for preservation. A garden map was prepared showing the various food production and experimental plots. Locations were also chosen for other garden facilities, such as terraces, a root cellar, cold frames, a compost area and a well. Most of these structures are connected by a large path, appropriately called Main Street. Main Street connects with the other major pathways in the garden and results in easy movement of people and materials in the garden area.



In the house, meanwhile, other preparations were underway. The young Tilapia destined to be the 1973 fish crop wintered in heated aquaria. Bob Angevine maintained official correspondence concerning business and legal matters. He also undertook the purchasing of the tools necessary to operate a basic shop for construction and building. Hilde Atema coordinated the Reader's Research program, and also designed a circular home, synthesizing people, animals, vegetable gardens, and pure energy with a sunken courtyard, swimming pool and a three-bedroom living area. Her design will be presented in a later volume of the Journal. We expanded the working area of the main kitchen by building a table along one wall, suitable for canning and freezing activities or for eating space on rainy days.

SPRING

The coming of spring initiated a flurry of activity as new projects were started. Last year's fish dome was replaced by a more permanent dome planned and prefabbed by Dave Engstrom, who also supervised its assembly. Bob put a fiberglass roof on the potting shed, as it soon became apparent that our seedlings would need more space than our cold frames could offer. Our garden



seeds, sunflowers, wheat, grapes, blueberries, and nut trees were planted in the ground as the season and the weather became more suitable. Main Street was leveled, a well was dug and several terraces were constructed. Permanent crops on the terraces thus far are strawberries and Jerusalem artichokes; rhubarb and asparagus are planned for the remaining terraces.

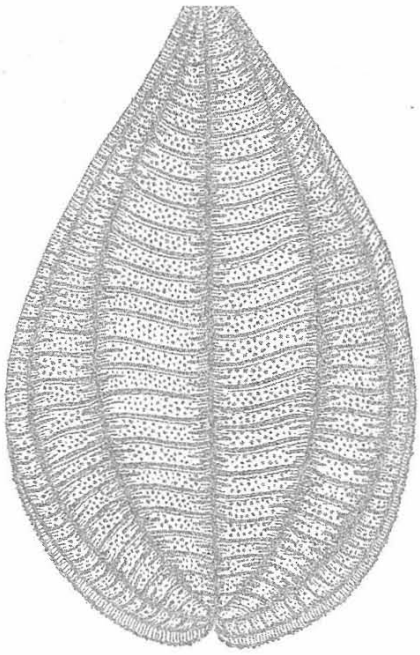
We have begun to integrate rabbit culture into the food chains of the farm, beginning with a buck and three does this spring. The rabbits can utilize food scraps and garden weeds to produce high quality protein. A fringe benefit is their manure which is an excellent worm-culture medium or compost ingredient. Marc Sherman is setting up a rabbit/worm culture system and is tying it into the existing tilapia cycle by using the worms as fish food. The wide variety of organic material that is acceptable as food for both the rabbits and the worms makes them valuable additions to the food production systems already operating.

SOLAR ENERGY DIGEST

Solar Energy Digest is a new monthly newsletter reporting the many direct and indirect ways in which solar energy is being put to work around the world. Its first issue came out in July 1973 and briefly covered such topics as large-scale solar power plants, power from ocean thermal gradients, a new solar house by Harold Hay, and a report on solar energy plans and projects by the National Science Foundation.

The Solar Energy Digest is edited and published by William B. Edmondson, who also plans to establish a solar energy research center in California. For subscription information, write

Solar Energy Digest
7401 Salerno Street
San Diego, California 92111



Reference

A SELECTED AND ANNOTATED BIBLIOGRAPHY OF NEW ALCHEMY INFORMATION

The references below provide an introduction to The New Alchemy Institute, its work and goals.

NAI PERIODICALS

The New Alchemy Institute Bulletin 1970-71

Bulletin No. 2 has been reprinted and available from NAI at $1.00 each. Includes the widely reprinted and translated "A Modest Proposal" which is a unique view of the maladaptiveness of modern industrial society. Proposes an alternative for the future that is restorative and within reach of men everywhere. Also includes "Design for a Tropical Center" which explores ecologically wise possibilities for land use and research in the tropics.

The New Alchemy Institute Newsletters 1972-73

The newsletters Nos. 1 and 2 describe New Alchemy activities and research. The first two newsletters contain information on aquaculture, waste systems, dome design, the countrywide research program involving lay collaborators, etc. Available from NAI at $1.00 each.

Newsletter No. 3 is an extensive treatment of methane systems and research. Includes a bibliography and designs for practical use. Available from NAI-West, 15 West Anapamu, Santa Barbara, California 93101 for $3.00 each. Reprinted: Still available.

The Journal of the New Alchemists 1973-

The Journal starting the summer of 1973 will reflect the increased commitment of the New Alchemists in creating a significant publication dealing with many aspects of new world planning. It will include specific "how-to-build" and design information, research and scholarly papers, and writings on untried ideas and systems on various subjects including: 1 Energy and its use; 2 Biological farming and land tenureship; 3 Waters and aquatic farming and husbandry; 4 Integrated systems linking the above—will include living shelters and "space ship" approaches to food growing adapted to northern climates; 5 Explorations, a section that will focus on learning and the pursuit of knowledge.

Available without charge to Associate Members of the Institute. Copies of Journal 1 can be purchased for $4.00 apiece.

Aquaculture Bibliography

If you are interested in fish farming, NAI has an Aquaculture Bibliography prepared by Dr. William O. McLarney. Includes references on polyculture and pond construction. Available from Readers' Service, Organic Gardening Magazine, Emmaus, Pennsylvania 18049. Price $1.00.

The Backyard Fish Farm Working Manual for 1973

This is a how-to-do-it manual for collaborators on our low-cost fish farm research. Edited by Bill McLarney. Gives details on setting up the miniature fish farm and collecting scientific information. Available from Readers' Service, Organic Gardening Magazine, Emmaus, Pennsylvania 18049. Price $1.00.

The Agricultural Research Workbook for 1973: Insect Resistance and Companion Planting in Vegetable Crops

Prepared by Richard Merrill. An ecologist's guide to experimentation in the garden. A critical and fascinating manual for those interested in researching food producing systems. The manual, some 50 pages in length, is being distributed to collaborators in our countrywide research program. If funds become available, we will print it for wider distribution.

INTRODUCTORY HEDGEROW BIBLIOGRAPHY

1. Boness, M. 1958. *Biozö notische Untersuchungen Über die Tierwelt von Klee-und Luzernefelden.* Z. Morph. Okol. Tiere. 47:309-75.

   Groups of invertebrates more numerous near the hedges of clover and lucern fields.

2. Caborn, J. M. 1957. *Shelterbelts and Microclimates.* Bull. For. Comm., London 29:1-135.

3. Elton, C. S. 1966. *Scrub and Hedgerow.* Chap. 9, *In:* The Patterns of Animal Communities. John Wiley & Sons Ltd., New York.

   This chapter has many references to hedgerow ecology. Some provocative ideas here.

4. van Emden, H. F. 1965. *The role of uncultivated land in the biology of crop pests and beneficial insects.* Scient. Hort. 17:121-136.

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8. Marquardt, G. 1950. *Die Schleswig-Holsteinische Knicklandschaft.* Schr. Geogr. Inst. Univ. Kiel. 13(3):1-90.

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INTRODUCTORY- COMPANION PLANTING BIBLIOGRAPHY

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2. Bio-Dynamic Farming and Gardening Association, Inc., *Herb Chart,* R. D. 1, Stroudsburg, Pa. 18360.

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11. Whittaker, R. H. and P. P. Feeney, 1971. "Allelochemics: Chemical Interactions between Species", *Science,* vol. 171, pg. 757.

BIBLIOGRAPHIES PREPARED BY:

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NAI-West
15 W. Anapamu Street
Santa Barbara, California 93101

SELECTED ARTICLES AND BOOKS BY NEW ALCHEMISTS

AGRICULTURE

Modern Agriculture and the Quality of Life
—by Richard Merrill

A three-part series: Part 1 "The Chemical Treadmill and Agricultural Pollution" (Vol. 2, No. 2); Part 2 "Agribusiness and the Decaying Rural Environment" (Vol. 2, No. 4); Part 3 "Ecology of the Green Counter Revolution" (Vol. 2, No. 6). Appeared in SURVIVAL Times, published by CEC, 15 West Anapamu, Santa Barbara, California 93101. Probably still available for 50 cents apiece.

Radical Agriculture
—a book by Richard Merrill

Richard Merrill has assembled a comprehensive collection of writings (mainly new material) by activists trying to create wiser uses of the land and help to return people onto the landscape. A must if you are into land restoration, biological farming or rural societies. Available from Harper and Row, Fall 1973.

Shaping an Organic America
— by John Todd

A four-part series intended to provide a rationale for a land-based science and the reconstruction of rural America.
Part 1 "Shaping an Organic America" (September 1971)
Part 2 "Designing a New Science" (October 1971)
Part 3 "The Organic Gardener and Farmer as Scientist (November 1971)
Part 4 "The 21st Century Homestead" (December 1971)
All appeared in Organic Gardening and Farming Magazine. Available in most libraries.

AQUACULTURE

Aquaculture Series for Organic Gardening and Farming Magazine
— by William O. McLarney

The series began in August 1971 and ran intermittently until the summer of 1972. The articles dealt with farm ponds as a food source; pond construction, crayfish culture, rearing of carp, etc. Invaluable introductory series for those interested in the rearing of aquatic foods. Organic Gardening and Farming Magazine, available most libraries.

Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms
— by J. Bardach, J. Ryther and W. O. McLarney. John Wiley and Sons, 1972, 868 pages, $37.50.

This is the definitive English language text in the field. NAI's McLarney was the primary contributor to the book. It's very expensive, but if you are going to commit yourself to aquatic farming you will need to read it. Ask your library to buy it. The cost is largely in the plates and illustrations which add a lot of value to the text.

ENERGY

New Alchemy Methane
— by Earle Barnhart

A companion article to the New Alchemy Newsletter No. 3 on Methane Systems. Alternative Sources of Energy, No. 11, July 1973, c/o Dan Marier, Rt. 1, Box 36B, Minong, Wis. 54859.

Sail Windmill
— by Marcus M. Sherman

A brief description of a simple three-bladed cloth windmill. Alternative Sources of Energy, No. 10, 1973, c/o Don Marier, Rt. 1, Box 36B, Minong, Wis. 54859.

THE LAY RESEARCH PROGRAM

NAI's people's research program in agriculture and aquatic studies. Designed to seek some of the answers for those interested in ecological farming and restorative land use. Countrywide. Organic Gardening and Farming Magazine is the basic forum for the exchange of information. Articles describing the program:

The Backyard Fish Farm
— by J. H. Todd & W. O. McLarney (O.G.F., January 1972)
Insect Resistance in Food Crops
— by J. H. Todd & R. Merrill (O.G.F., March 1972)
Ecological Design in the Organic Garden: Companion Planting and Natural Repellents
— by Richard Merrill (O.G.F., April 1972)
The Readers' Research Program for 1973
— by John Todd (O.G.F., April 1973)

NEW ALCHEMISTS AT WORK — THEIR IDEAS & PHILOSOPHY

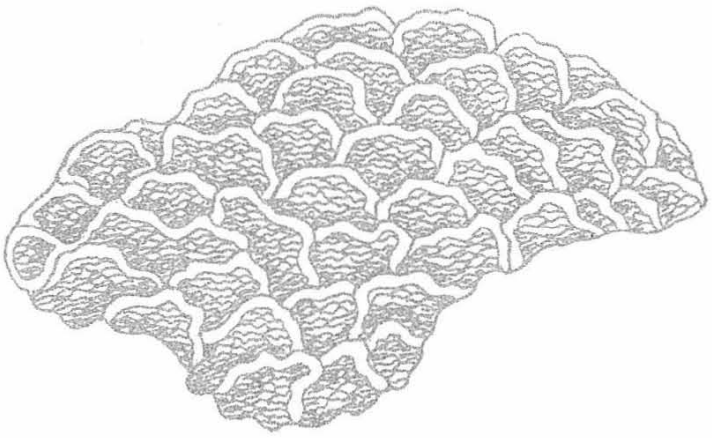
Lifestyle Interviews the New Alchemists
— by Five New Alchemists
who describe what they do and why.
Appeared in Lifestyle: A Magazine of Alternatives No. 2
Available from Lifestyle, P. O. Box 1, Unionville, Ohio 44088. Cost $1.35.

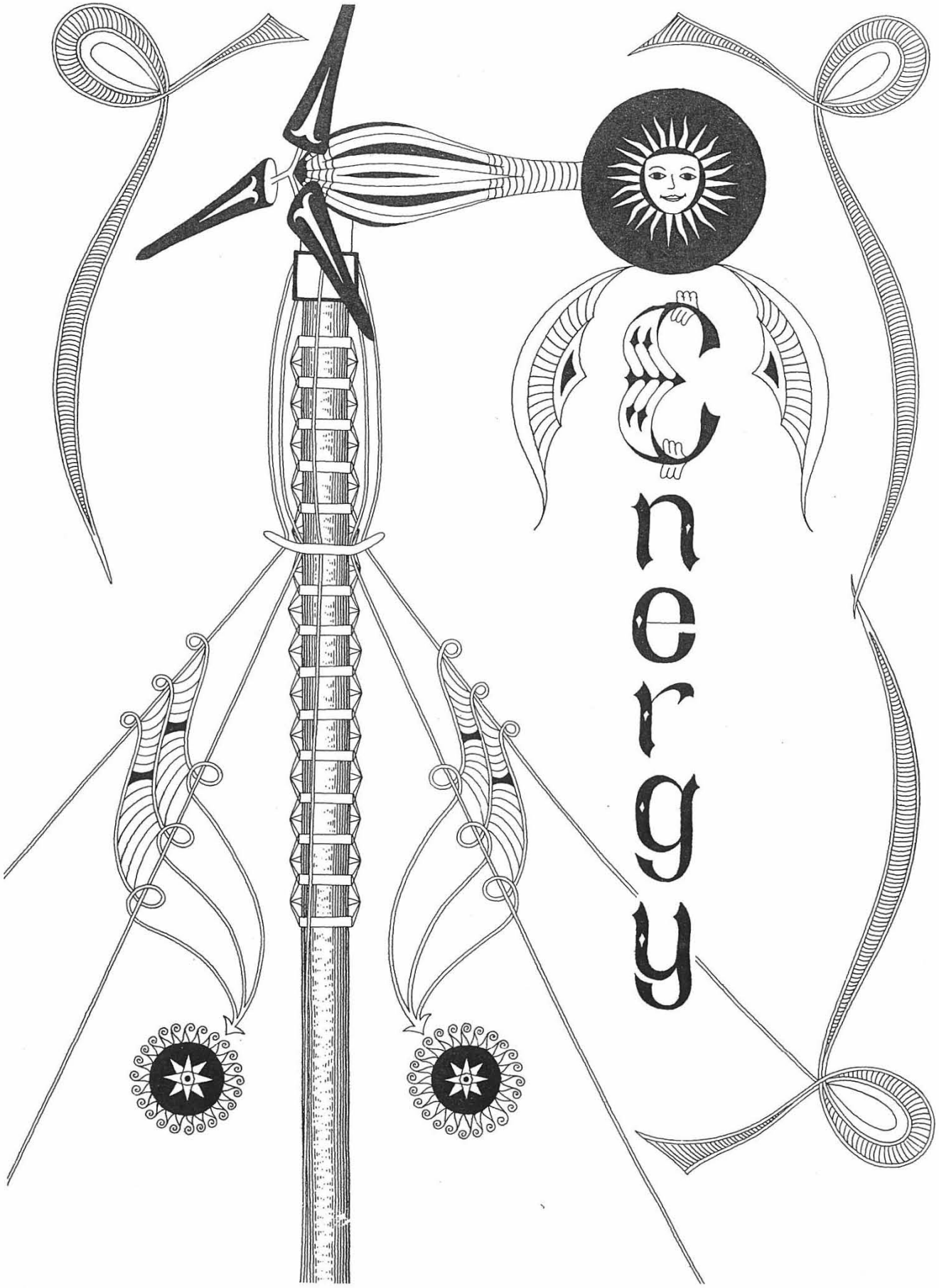
The Third Alternative
— by Robin Clarke and John Todd

Deals with the moral crisis in science and describes how people like the New Alchemists and their European counterparts are searching for knowledge, and ways of living, that are ecologically adept and libertarian in scope. To appear in Harper's Magazine.

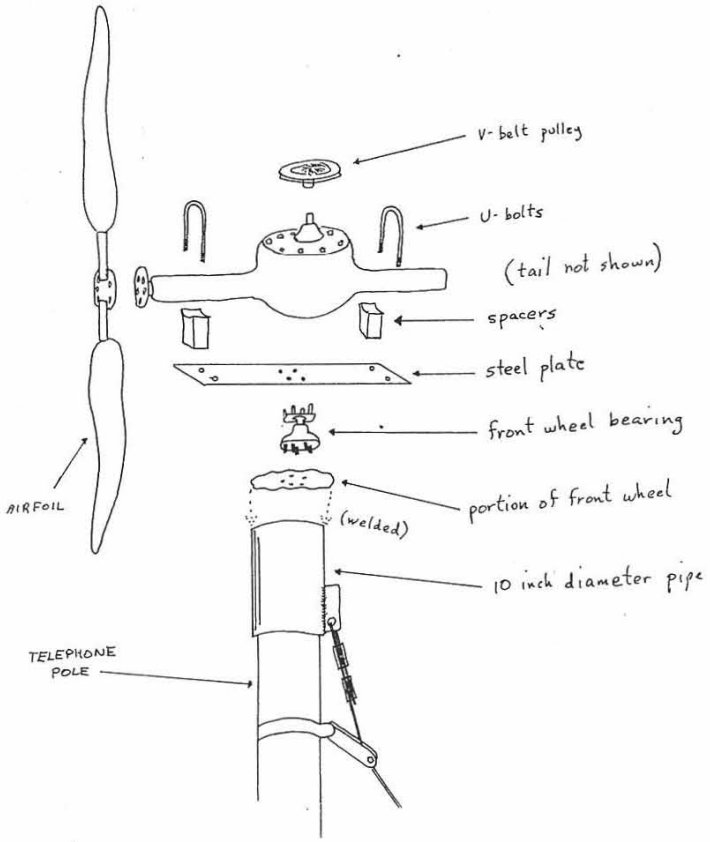
New Alchemy on Cape Cod
— by Nancy Todd and John Todd

It's what the title says it is. In the "Cape Naturalist", June 1973. Available from the Cape Cod Museum of Natural History, Brewster, Massachusetts 02631. Price 50 cents.




Energy

Wind Power



There are three windmills now on the brink of the hill overlooking the gardens though to someone unfamiliar with this peculiar form of ingenuity, they might as likely appear to be experiments in mobile sculpture. From the tails of two of them enigmatic suns smile down at us as they turn. The third, like a dislocated cylinder, consists of two canary yellow oil drums spinning around each other.

A good deal of our time and thought is spent on working with non-polluting energy sources, and on Cape Cod this has led to concentration on capturing the energy of the wind. Earle Barnhart and Marcus Sherman are our inventor-engineer-mechanic-tinkers in residence. As last fall wore on we would often find them thawing in the kitchen after being buffeted about on the windmill tower for as long as they could bear.

Their work is not without its moments of glory. Last November we were contacted by Peter Jones of the B. B. C. who planned to make a film about dissident scientists. We said that he might do any filming he thought appropriate at the farm. He arrived with his crew one blustering morning. Marc and Earle as usual were at their post at the top of the forty-foot tower. Windblown and heroic, they swayed on the high pole. After several hours of work, they sawed off the working platform, climbed down, then released the re-straining ropes. The cameras whirred as we watched. After agonizing moments, for the first time, slowly, the blades began to turn.

But then it's not always like that.

Several experimental windmills are turning now to take advantage of one of the Cape's major energy sources. One is a large wind generator to produce electricity for tools and pumps, another a small wind charger to supply lesser amounts of electricity for radios or for a single storage battery, and a third is a Savonius rotor to produce mechanical energy for water pumping. All are designed to be low-cost and simple to make or to repair.

WIND TURBINE-GENERATOR

Tower: The tower is a 42-foot telephone pole, guyed by five cables to buried phone pole segments.

Mounting: The windmill's main pivot is the bearing and axle from the front wheel of a Rambler automobile welded to a thirty-inch section of 10-inch diameter pipe which fits over the top of the pole.

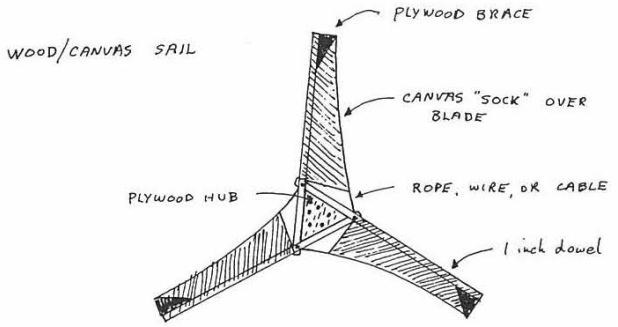
Power transmission: The rear differential and drive shaft unit from a discarded Rambler is the body of the windmill. It is U-bolted to a steel plate which in turn is bolted to the pivot bearing. (The drive shaft stub should not point downward or it will leak oil.)

Blades: The hub with attached blades is bolted to one end of the differential on the 5 original wheel-mounting bolts. Our first set of blades was designed and built by Bill Smith of Hull Cove, Rhode Island. They were 10 feet diameter, 2-bladed, fiberglass, high-speed airfoils, designed for 12 mph winds. Their starting torque was rather low for our 9 mph average winds, but they worked well and gave very high rpms. We also tried a 3-bladed medium-speed canvas sail prop which worked quite well until an ice-storm got it.

Electrical system: We put a belt-pulley on the drive shaft stub of the differential, and V-belted a 12 volt auto alternator to it. The differential is geared up 4:1 and the pulleys 3:1, giving us a 12:1 step-up in rpm from the blades to the alternator. With the turbine blade, this was enough; with the sail blades, more gearing is necessary. A 12 volt battery and a regulator are mounted on the differential to charge the field coils; electricity is then transferred to the ground via a cable.

Tail: A plywood tail is U-bolted on the differential opposite the blade end from which the axle has been removed.

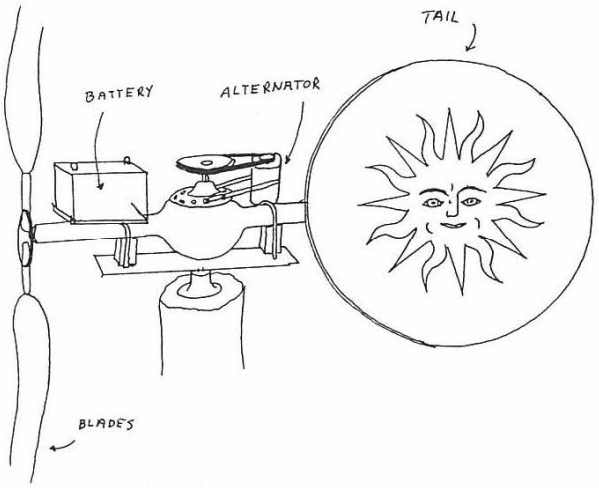
Changes: We are switching from high-speed fiberglass air-foils to medium-speed sail wing blades, adapted from the Princeton sail wing studies.[1] We'll have three blades instead of two, using aluminum shafts as the leading edge, taut cable as the trailing edge, and dacron wing surfaces. They will trail downwind



of the tower, probably at a slight dihedral angle for added stability. Higher gearing will be necessary (about 20:1), but we feel that a larger blade diameter (15 feet), simple construction, and less centrifugal stress will make the test worthwhile.

We are not ready to report on the electronics until the mechanics are completely worked out. From most reports in *Alternative Sources of Energy*[2], a simple cord running down from the generator is an acceptable alternative for slip-rings, needing only to be unwound periodically. We are still debating between a 12 volt or a 120 volt generator; in either case, golf-cart batteries will be used for storage because of their ability to take complete charge-discharge cycles and their relatively long life.

If you plan to use an auto differential, leave the brake drum on the hub end with which to stop the blades for inspection and maintenance. It is possible to let the emergency brake cable hang down within reach.

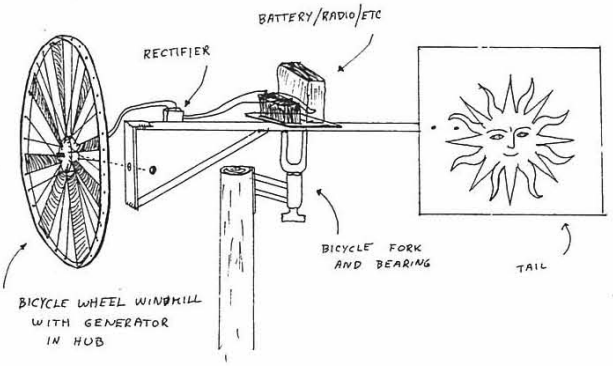


SMALL BICYCLE WHEEL GENERATOR

This windmill is useful where small amounts of electricity are needed as in running radios, cartridge players, or in charging storage batteries. It is made from a Sturmey-Archer Dyno-Hub bicycle wheel minus the tube and tire and has a small generator built directly into the hub. Eight blades are formed on the spokes by attaching sheet metal strips between adjacent spokes from the rim to the hub. The proper spokes are those which form slightly twisting blades nearly parallel with respect to the wheel at the rim and gradually turn to about 45° to the wheel at the hub. This shape is favorable aerodynamically to produce the high rpms for which the generator was designed.

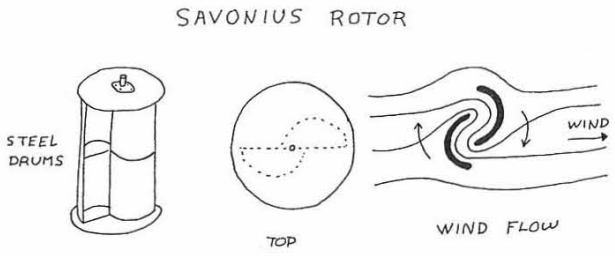
The wheel is mounted by one of the original hub bolts to a simple metal body made up of 1 inch of water pipe with a sheet metal tail on the other end. This is assembled and welded to a cut-off bicycle fork and steering bearing and attached to a fence post.

Output of the generator is 6 volt AC, and is changed to 6 volt DC by a diode and a resistor. A detailed circuit diagram and variations of bike generator windmills are in the U. N. energy conference, Volume 7[3].



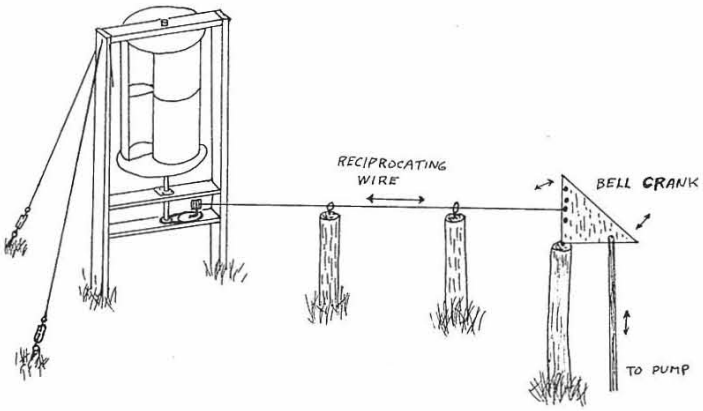
SAVONIUS ROTOR

The Savonius rotor, although only about half as efficient as a multi-bladed windmill of the same wind-sweep area, has several advantages that make it appropriate for home construction and use. It spins on a stationary, vertical axis regardless of wind direction and it is therefore a simple matter to take power directly from the rotor shaft. It is very simple and cheap to construct. Adjusting the diameter of the rotor wings varies the rate of spin in identical areas and wind-speeds.



Our present Savonius rotor is a variation of the Brace Research Institute's design[5], using 55-gallon steel drums cut lengthwise and welded into two off-set cup-shaped blades. Bearings at top and bottom in a guyed wooden frame complete the rotor. (A few hints: Use 4x4 inch lumber for the frame; balance the rotor carefully; and wire the turnbuckles when tight as they can vibrate loose.)

We coupled this system to a reciprocating wire power transmission, which was originally used by the Pennsylvania Amish to transfer power from a waterwheel[6], in order to pump water from our hand-dug well. A reciprocating wire transmits the energy from a bicycle crank below the windmill to a lever above the well. Each horizontal wire stroke is converted to a vertical pump stroke.



Using the Brace plans an optimum pump stroke can be calculated from the average windspeed, pump diameter, and height of lift. By choosing various ratios of the lever, we can set the windmill for different windspeeds. Experience has shown that a large crank with a long wire stroke will produce serious wire vibration problems as will a fast reciprocating frequency. We geared the windmill to the crank at a 2½:1 ratio and settled on a six-inch wire stroke. The wire supporting poles are 15 feet apart. we have our pumping system set to start in an 8 mph wind and pump between windspeeds of 6 and 30 mph. It pumps water into a storage pond at a head of 17 feet.

— Earle Barnhart

NOTES

1) *Popular Science*, November 1972.
Aviation Week and Space Technology, November 13, 1972, p. 47

2) *Alternative Sources of Energy*, bi-monthly magazine, 2/year from Don Marier, Rt. 1, Box 36B, Minong, Wisconsin 54859

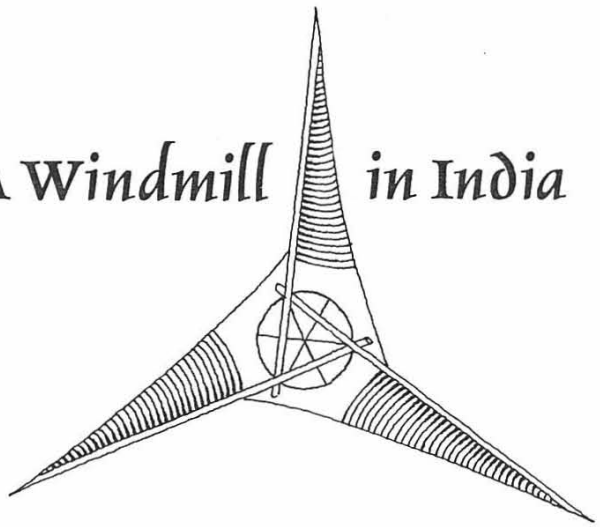
3) Proceedings of the U. N. Conference of New Sources of Energy, Volume 7, pp. 340-345.

4) *Mechanical Engineering*, Volume 53, No. 5, May 1931, "The Savonius Rotor and Its Applications" by J. Savonius.
Mechanical Engineering, Volume 47, No. 11, pp. 911-912, "The Savonius Wing Rotor" by Alexander Klemin.

5) "How to Construct a Cheap Wind Machine for Pumping Water" (pamphlet) — A. Bodek.
"Performance Test of a Savonius Rotor" (pamphlet) M. Simonds and A. Bodek.
Both from: Brace Research Institute, MacDonald College of McGill Univ. St. Anne de Bellevue 800 Quebec, Canada

6) "Reciprocating Wire Power Transmission for Small Water Wheels"
From the *Village Technology Handbook*, pp. 117-122
VITA, College Campus, Schenectady, New York.

A Windmill in India



While other members of the New Alchemy family were deciding to spend the winter in France, Costa Rica, California and good ole wind-swept Cape Cod, I chose to return to the nine acre peanut farm of my friend Tim Heineman in South India. Tim's farm is located outside of a small village among some rolling hills near Madurai, Tamilnadu state. During my previous stay at the farm in 1971 we had talked about installing a well and a water pump near Tim's mud hut so that we would not have to haul water manually in buckets up from the stream for drinking and cooking. At that time the only supply of water was a small stream flowing through the farm that goes completely dry during the winter drought and floods during the monsoon in the spring. Tim wanted the new pumping system to be able to irrigate a one acre vegetable garden all year round in addition to watering the cattle and supplying the hut. We realized that there were many problems to overcome if we were to install an independent, cheap and reliable water supply system.

In many parts of India including Tim's farm there are adequate supplies of ground water which are unavailable to farmers during the dry season because of inadequate power sources for pumping. Three to eight horsepower diesel pumps are frequently used but are expensive to operate because of the high cost of imported oil and often must be taken out of service for costly and time-consuming repairs. Efficient five horsepower electric pumps are being used more and more as rural electrification proceeds, but only well-to-do farmers can afford to buy and maintain them. This winter in South India there was a 75% power cut to the rural areas due to heavy consumption in the cities and to overexpansion of the power grid without a corresponding increase in supply. This power shortage means that there are only four hours of electric pumping per day. This situation is expected to worsen for the next four to five years until the Indian Government begins operation of atomic power plants in South India. At the present time bullock operated pumps remain the most common and reliable source of irrigation water for subsistence farming. Water for domestic use is usually hand-lifted with a rope and bucket from open wells.

During the early 1960's the Wind Power Division of the National Aeronautical Laboratory in Bangalore, Mysore, developed, tested and produced two hundred 12-bladed fan-type windmills which demonstrate the feasibility of using wind power to pump water to South India. Several types of imported European and American multibladed windmills have also been used to harness India's abundant wind energy resources. However, due to lack of public awareness and the unavailability of simple and inexpensive devices, wind power is only occasionally exploited.

With these thoughts in mind I returned to the States for one year. While working at the New Alchemy farm on Cape Cod, Earle Barnhart and I built and tested a three-bladed cloth sail windmill which appeared to be simple and efficient enough for practical use on Tim's farm.

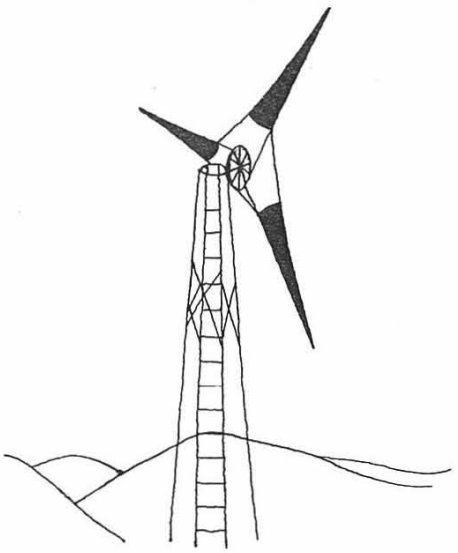
Cloth sails with a wooden framework have been used for hundreds of years for transforming the useful energy of the wind into labor-saving mechanical work, especially for grinding grain and pumping water. The use of windmills spread from Iran in the seventh century A. D. to coastal China where the application of the art of sailmaking significantly improved the sophistication of windmill construction. Heavy rigid wood wind-

mill blades surfaced with cloth were used increasingly throughout northwestern Europe and by the seventeenth century the Netherlands had become one of the world's richest and most industrialized nations largely as a result of extensive exploitation of windpower with ships and windmills. Cloth was a natural choice for windmill sails because of its acceptance and wide use in sailing ships. It is lightweight, easy to handle, readily and cheaply available, and most important, it forms a strong uniform surface for catching the wind when firmly supported at three or more points.

In the Mediterranean region flour-grinding and oil-pressing mills were rigged with six to twelve triangular cloth sails set on simple radial spars. A three dimensional array of guy ropes radiating from a central spar projecting out along the axis of the main shaft, suspended the sails in position, rather than the heavy grid of wood used in the traditional Dutch-type windmills. This sailboat jib type of rigging was a significant improvement in windmill design which encouraged the spread of windmills throughout the deforested Mediterranean countries. The wind capturing area of these windmills was controlled by wrapping each cloth sail around its spar. Though requiring daily rigging adjustments and occasional replacement of tattered sails, the efficiency and simplicity of these windmills resulted in their widespread use in Rhodes, the Black Sea coast, the Aegean Islands and Greece. In Portugal their use was accompanied by the sound of whistles attached to the rigging, an audible indicator of the wind at work. In the West Indies large sailwing windmills were commonly used for crushing sugar cane. Many handcrafted windmills with eight triangular jib sails are presently pumping irrigation water in the Plain of Lassithi, Crete. In Japan four-bladed jib sail windmills are used to operate reciprocating pumps which supply water to vegetable gardens. A high-speed aerodynamic two-bladed sail wing is being developed at Princeton University. Further construction simplifications may make it applicable to use in less developed countries.

A windmill with four self-adjusting cloth sails has been developed by Mr. H. Stam for rural markets in less industrialized regions. Its relatively complex design is limited because of the difficulty in connecting it to a deep well pump. Unfortunately, it cannot be manufactured by hand using local materials. Those people who are in a situation to most benefit from a windmill are also those least able to pay for it. If the critical moving parts were separately available, a small farmer could purchase the remaining materials needed and assemble the windmill in his own village using local skills and labor. This way a major portion of the money spent would remain in the village.

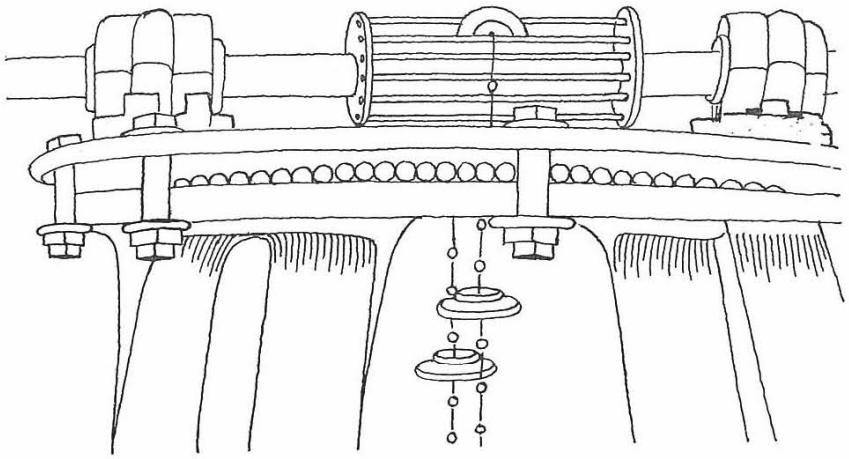
Upon returning to India this winter I discussed some of the problems of building a small practical windpowered pump with scientists at the Indian Institute of Agricultural Research in New Delhi. It was suggested that I



set up the windmill that I was planning for Tim's farm with a modified paternoster pump like those used to drain mines in England many years ago. I was given a working demonstration of some chain pumps at the I. A. R. I. and was told that a chain pump is easily and cheaply built and has the advantage of being more efficient than most other types of pump. Unlike some other pumps it operates well with a low speed variable power source like a windmill. Recently chain pumps have been replacing the traditional square pallet pump and the Noria water lifting wheel throughout China.

My friends in Delhi wished me good luck and I merrily proceeded on a delightful three day train ride by third class coach to the southern tip of the Indian subcontinent. I arrived at Tim's farm and we soon began construction of the windmill.

This sail wing windmill is made of a one-meter diameter bullock cart wheel to which three bamboo poles are lashed in a triangular pattern with overlapping ends. Each bamboo pole forms the leading edge of a wing, and a nylon cord stretched from the outer tip of the pole to the rim of the wheel forms the trailing edge. A stable and lightweight airfoil results from stretching a long narrow triangular cloth sail over that bamboo-nylon frame. This wing configuration, a hybrid of low-speed eight-bladed Cretan sail wings and high-speed two-bladed aerodynamic sail wings, produces high starting torque at low wind speeds. The bullock cart wheel is attached at the hub to the end of an automobile axle shaft which rotates in two sets of ball bearings. The shaft and bearing assembly is mounted horizontally on top of a turntable. The turntable consists of two circular steel plates separated with a raceway of ball bearings and held together with a ring of eight bolts which encircle the bottom plate. A one-foot diameter hole through the center



of the turntable will allow the chain and gaskets of the chain pump to go up and around the "squirrel cage" which is mounted at the center of the auto axle. If a reciprocating deep well piston pump were desired, the reciprocating rod, rather than a chain, would go through this hole and the crankshaft rather than an axle shaft would be mounted on top of the turntable. Since the blades have a slight built-in coning effect and the axle or crankshaft is mounted slightly off center from the center line of the turntable, the blades act as their own tail, trailing in the wind. Because the blades are downwind from the tower, there is no danger of the bamboo poles bending in a monsoon wind and hitting the tower. The tower is made of five 25-foot-long teak poles set in concrete at the base and bolted at the top to five angle irons welded at a slight flaring angle to the bottom of the turntable. The tower tapers in towards the turntable at the top from a seven-foot diameter at the base. It has cross bracing and a ladder.

This eight-meter diameter windmill lifts three hundred pounds to a height of twenty feet in one minute in a ten mph wind. This is accomplished by a rope passing over a six-inch pulley on the main drive shaft. This lift is now being used to raise soil and rock from the 20-foot deep well which is being dug below the windmill. When the well is finished the pulley will be replaced by the "squirrel cage" of the chain pump.

I hope that other people will continue to refine and adapt this windmill to their own needs and materials. If you have any inquiries or suggestions for improvement, I will be pleased to reply.

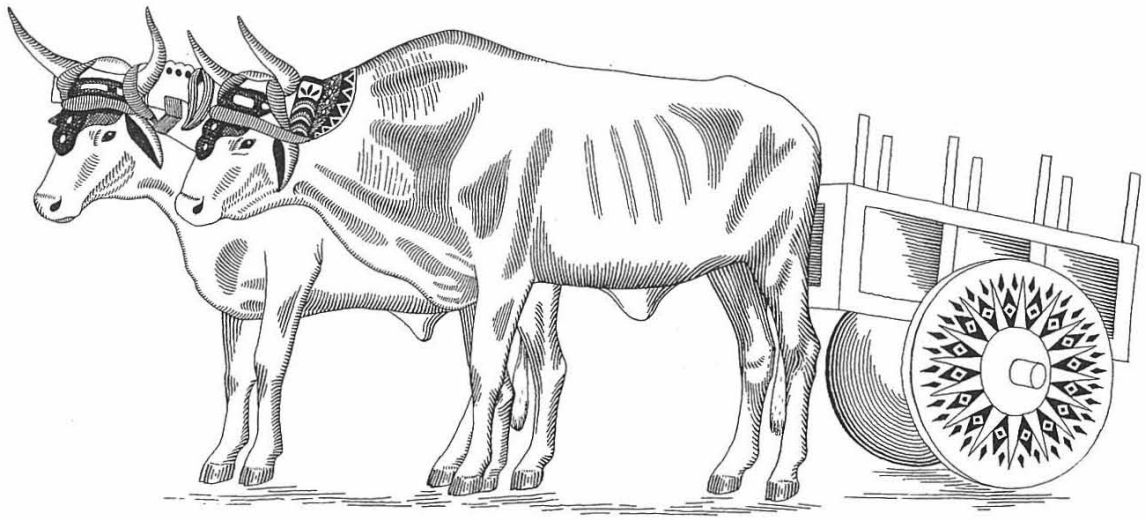
— Marcus M. Sherman


Land and
its Use

Costa Rica

The superiority of the bleak north to tropical regions, however is only in their social aspect, for I hold to the opinion that, although humanity can reach an advanced state of culture only by battling with the inclemancies of nature in high latitudes, it is under the equator alone that the perfect race of the future will attain to complete fruition of man's beautiful heritage, the earth.

– Henry W. Bates
A Naturalist on the Rivers Amazon
(circa 1850)



A Thumbnail History

Nine of us from the Cape Cod farm spent two months in Costa Rica this winter. It is a particularly appealing place for people from Massachusetts to spend February and March, but the articles that follow will indicate that it was not only a glorious holiday, but also a chance to test our ideas against new parameters and to learn the problems and needs of climates and cultures other than our own.

Both Bill McLarney and John Todd had been in Costa Rica before as readers of Newsletter No. 1 will probably remember. They knew of the scope for New Alchemy's approaches in the areas of both land restoration and protein deficiency. This year we saw a fair amount of the country and came to appreciate something of its problems and uniqueness. The articles that follow make no pretense of being comprehensive. The first is a thumbnail sketch for people who know that Costa Rica is probably in Central America but are rather foggy about anything beyond that. The second is a kaleidoscopic verbal slide show which describes something of what we saw and felt as we travelled. John Todd's essays discuss tropical agriculture in terms of the threats that current practices pose to the land and of the possibilities of adopting restorative ideas and methods before damage becomes irreparable.

Costa Rica is the second smallest country in Central America with a population of 1,800,000 and an area of 19,575 square miles, and is located between Nicaragua and Panama. Spain's interest in Costa Rica was first aroused by Columbus who landed at Puerto Limon in 1502 on his fourth and final voyage to the new world. He was met by Indians of the Carib tribe who were wearing golden ornaments which at once, of course, piqued the attention of the Spaniards, and gave the country its name. Columbus was followed by successive explorers but none found enough in the way of the desired gold or other resources to warrant large scale exploitation. Apart from Roman Catholic missionaries to the Indians, by far the majority of Spanish colonists in Costa Rica came and remained as settlers. As the Indians they encountered upon their arrival were either killed in their fierce resistance to having their territories encroached upon, died from their exposure to white men's diseases or retreated to remote areas, there were few indigenous people to be subjugated into a serving class. The pattern of the country then was formed early and has basically remained one of small, largely self-sufficient landholders, giving it a comparatively homogeneous social structure.

Until almost the middle of the 18th century, Costa Rica was an outpost; a small, isolated, little known and extremely poor colony of Spain. The people, who remained mainly pure-blooded Spanish, labored long and hard on their land to stay alive and were often too poor to have suitable clothes to go to church. They had little time or money for education or culture and had neither a subservient nor dominant social class to influence their way of life.

Although little of the turmoil caused by the waves of nationalism and revolution of the late 18th and early 19th centuries was felt in Costa Rica, when Costa Ricans learned in October 1821 that Guatemala had declared its independence from Spain, they voted on November 1, 1821 to do so as well. No opposition from Spain was encountered. Political independence brought closer ties with other Central American countries as they tried to forge the United Provinces of Central America which functioned sporadically until 1848.

In 1797 the cultivation of coffee was introduced. By 1829 it was the country's major export. This rather unexpected boom brought other changes. Coffee was a highly marketable rather than subsistence crop and led within surprisingly few years to the establishment of larger plantations and to increasing prosperity for the growers. With the beginnings of even a modest amount of wealth and leisure came the evolution of some cultural life and inevitably the dominance of political affairs by a few wealthy families. A railway was built, linking the coffee producing areas of the central part of the country with Puerto Limon on the Caribbean coast and facilitating greater communication both within the country and with the world beyond. The railway was built by an American under contract to the Costa

Rican government. To build it he brought in large numbers of Jamaicans whose descendants remain in Limon Province and constitute the major significant racial and cultural minority in the country. By providing access to a port from inland areas, the railway made possible the establishment of banana plantations. Bananas have become second only to coffee as an export.

In the hundred and fifty years since Independence and the introduction of coffee, the life of the Republic has become considerably more complex. The government tourist agency, El Instituto Costarricense de Turismo, declares in its circular that "the country has become famous for the hospitality of its people, its stability, its high cultural level and widespread public education". It is rather a smug assertion, but characteristic of tourist circulars, and there certainly is some justification for what is said. As Latin American countries go, it has been remarkably stable. It cultivates the image of the "Switzerland of the Americas", a bastion of democracy and tranquillity amidst the political turmoil and violence of its neighbors.

The form of government is democratic. Its present form is based on a constitution adopted in 1949, after a brief revolution. Suffrage is universal and compulsory. The army was abolished for the second time in the country's history to prevent seizure of government control by the military. The Communist party was outlawed but has since been reinstated. Order is maintained by the Civil Guard and by the Town and Village Police.

There are many political parties but at the present the P. L. N. (the Partido Liberacion Nacional) is in power and is the most popular, usually requiring the mustering of several others into a coalition to oppose it. The P. L. N. first gained prominence in 1948 under the leadership of José Figueres as representing the growing middle class and opposing the strange bedfellows of the Communists and the wealthy upper class. Figueres was elected president for a second time in 1970. The next election is in February 1974 and Costa Ricans are already actively campaigning. Bright banners are flying and posters are being displayed everywhere.

Costa Ricans take great pride in their educational system. Education is free and compulsory. The literacy rate is considerably higher than that of other Latin American countries, and the University of Costa Rica is well-established. Yet one critic has said that the average Costa Rican remains in school only 3.5 years, just long enough to be firmly persuaded that he is unusually blessed in having been born a free citizen of a modern and progressive democracy.

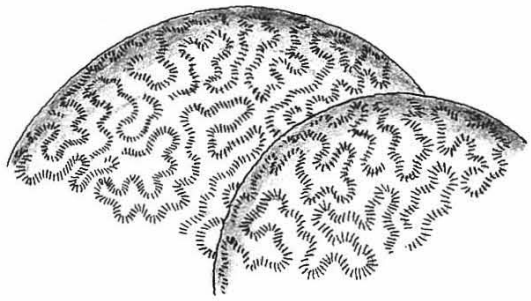
Regrettably, I have to differ with the Instituto de Turismo with regard to the "high cultural level". We were struck by the conspicuous lack of evidence of an indigenous culture, particularly in the forms of architecture or crafts which would be the most immediately apparent to an outsider. With the exception of the native ox cart and the ancient Indian gold work and pottery, there is little that is unique or memorable, and we could not account for this until we learned of the centuries of struggle merely for subsistence.

Costa Ricans are with few exceptions almost entirely Roman Catholic, although many are only nominally so. The Church receives financial support from the government, and although it is denied political activity, its influence is strong. Apparently governmental support is given in the hope that the Church will buffer the temptation of Communism for the people.

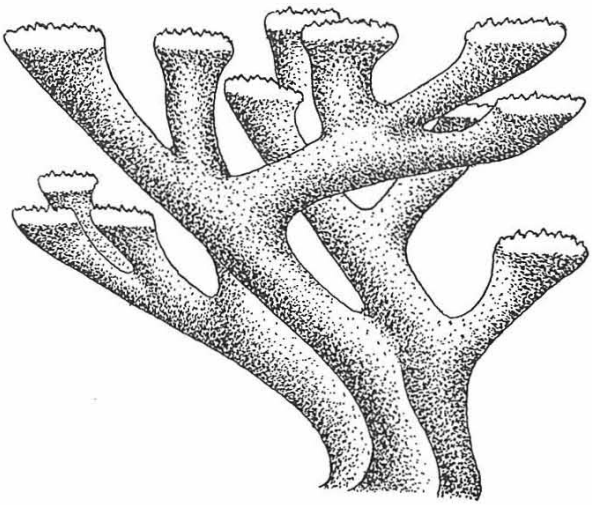
Again El Instituto de Turismo.... "However the country is fast becoming industrialized thanks to the abundance of raw material and cheap power, to the skill of its laborers, to its ideal location in relation to important markets, to its ready means of communication and the substantial incentives it offers for establishing industries with local or foreign capital." With such official policy it will surprise no one to learn that foreign investors have responded with predictable and characteristic alacrity and names like MacDonalds, Honda, Texaco, Volvo, Peter Pan and endless others proliferate.

The most dismaying aspect of this to a North American, at least to one that is not an admirer of the dominant culture, is that in their pride in being "progressive" and "modern", in their anxiety to acquire consumer goods and a higher standard of living, Costa Ricans display an eagerness, even naiveté, which is almost frightening. It becomes even more ominous when one of the names mentioned in connection with many developmental schemes is that of Robert Vesco, a prominent participant in the Watergate affair. Rumors are many and elusive about Mr. Vesco's activities. His private 707 at the airport bears witness to his interest in the country. One cannot help but see the signs of exploitation everywhere, and wonder how a people can so willingly let their exquisite country drop, like a ripe plum, into the hands of "developers".

— Nancy Todd



Travel Impressions



MESETA CENTRAL

We flew from the States to San José, the capital of Costa Rica. San José is geographically as well as politically and socially the center of the country. It is almost mid-way between the Atlantic and Pacific, on a high plateau called the Meseta Central which has an altitude that ranges between 3000 and 5000 feet, and a climate that is close to perfection. Many days in the dry season are warm and sunny but not humid, others bring rushing winds or tumbling clouds. The nights are cool and starry. In the rainy season there are bright mornings and wet afternoons, which seems an admirably well-regulated system, although when we left Costa Rica it was in the grip of the worst drought in fifty years. Water and electricity were severely rationed, and everyone was anxious for the onset of the rainy season.

Ringing the Meseta Central are ranges of mountains and volcanoes, some extinct and others not. The best known and most active is Irazu which erupted in 1963 causing considerable devastation from falling ash. Now it rumbles steadily but quietly and is a great tourist attraction.

One of our favorite places in the Meseta Central was the farm of New Alchemy Associate Peter Scherman. His farm is on Volcan Barba, outside the town of Heredia. It would be difficult to conceive of a more beautiful place and it is a rather happy thought that it is in the hands of someone who will never abuse it but only try to understand and care for it.

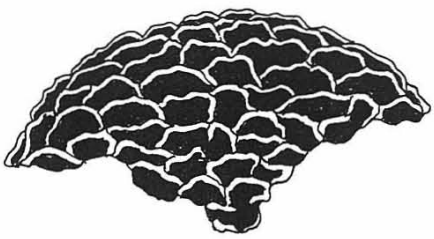
Late one afternoon, I could think of nothing nicer to do but climb one of the hills and sit, just looking. This is what it was like.

The wind blows gently. The sun burns a hot patch on my right thigh and my cheek. It is moving lower to set over the Pacific in an hour or so. It casts long shadows of me and of the young guava trees around me. The shade is deep and dark under the row of cypress trees behind. Over my left shoulder is a high hill, much higher than this, one of the shoulders of Volcan Barba. It is a patchwork of woods, cypress, and grazed fields. The hillside is cut by streams, lined with columns of virgin forest. On the flank of the hill opposite are fields of sugar cane, banana and coffee. Through a valley on the plain below, I can see San José and on to the high mountains beyond. The city is under cloud but lit by the slanting rays of the late afternoon sun, so that the buildings are like toys - tiny, white and distinct. On the right, in the foreground, is a continuation of cultivated fields. From here, the fields of sugar cane look like carefully cropped lawns. Farther away, the hills merge into mountains, and beyond the mountains, there is a glimmer that is the sea.

SARAPIQUI

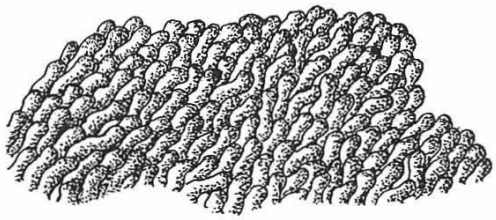
Most roads in Costa Rica take San José as their focal point, and so traveling is usually done from San José outward, like following the spokes of a wheel. Our first spoke led over the mountains almost due north to Sarapiqui.

As the mountains surrounding the central plateau taper to hills, they become, through some quirk of their geological past, strangely rounded yet steep-sided, looking like so many irregularly-sized eggs up-ended in a container. Some of the hills are wooded but many have been cut and turned over to cattle. The hills flatten gradually to a plain that extends steamy, rolling and green to the Caribbean.



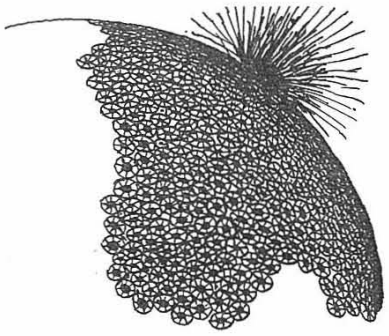
It is the humidity and the plants of Sarapiqui that one notices most immediately. Although much of the jungle is second growth, it remains lush and dense. A few giant trees have been left standing and they are magnificent whole worlds in themselves with looping, trailing lianas, and countless epiphytes of every description from fern to glossy philodendron to orchid. Wasp and oropendula nests swing from the branches, lizards flash along the trunk, and birds are a continuous moving presence. Climbing one of the hills at dusk, the landscape has a quality of a painting by Turner, as a cloud drifting down from the mountains wraps the distant hills in mist, fills the valley, and filters the sunset.

In Sarapiqui, as in every other part of Costa Rica we visited, the rivers are a constant source of pleasure. It is a law that the trees bordering the rivers must not be cut, and this law unlike others, equally wise with regard to the preservation of their country, Costa Ricans have chosen to observe. So, always under immense gnarled trees, the rivers flow over sand or rocks, slowing and eddying to form pools or rushing along in swirls or rapids, sometimes just drifting. The intense tropical light and nearly vertical sun are shaded and softened. There are secret, shadowy places reflected in the water. Used as we are to the inaccessibility of our polluted rivers, we loved the freedom of finding a cool river and tumbling in, the children looking like small flowers borne along on a tropical stream.



VALLE DEL GENERAL

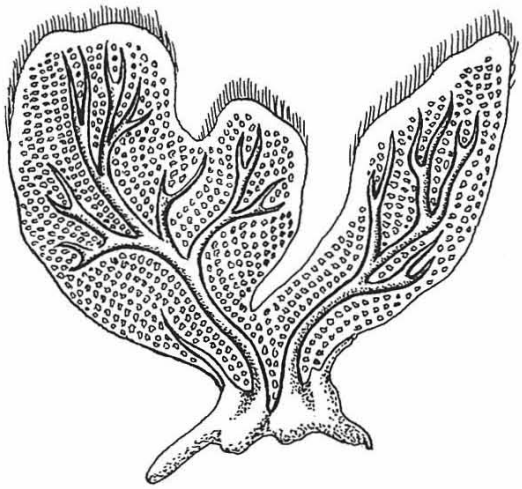
South across the mountains from San José, over the Cerro de la Muerte, the Hill of Death, in the Valley del General lies San Isidro, a bustling little place with the air of a frontier town. The drive from there to the Pacific over now familiar humpy hills is almost perpendicular most of the time, with some sort of apex midway that has the general effect of reversing one's angle of travel. It is one of the bumpiest drives in a country of very creditable bumps and one of the most beautiful. The sky is brilliant, the sun searing and the land still green, although showing signs of drying under the strain of supporting cattle. Much of the forest has been cut for pasture, leaving the way clear for erosion and leaching of the soil. From some of the hilltops there are dizzying views of land and sea and sky, the breath-taking sweeps one would usually see only from a plane.



We came to the sea at Dominical. Following the pattern of much of the continent, the Pacific coast is drier and brighter than the Atlantic, the light and heat being at times almost unbearably strong, even the water is hot. The sea and sky there are brilliant blue, the land spring-green, the beach curves toward the distance shimmering with heat. Coconut palms line the beach. Between them were smaller leguminous trees blossoming with pale pink flowers and sea grape which were losing leaves and changing color so the fallen leaves of red and yellow lay scattered on the beach and floating in the water like ghosts of northern spring and autumn side by side.

The beach was unbelievably empty. A few families were camped under the palms in makeshift tents. Our other beach companions were chickens, lizards, cows and an occasional rooting pig. They were all quiet and well-mannered and didn't litter the beach with beer cans. The most astonishing creatures we saw here were great four-foot iguana called chicken of the jungle. Defying the usual stereotype of the reptile as swift-moving and graceful, this unfortunate lizard is rather stout and crashes through the underbrush with an ungainly waddle.

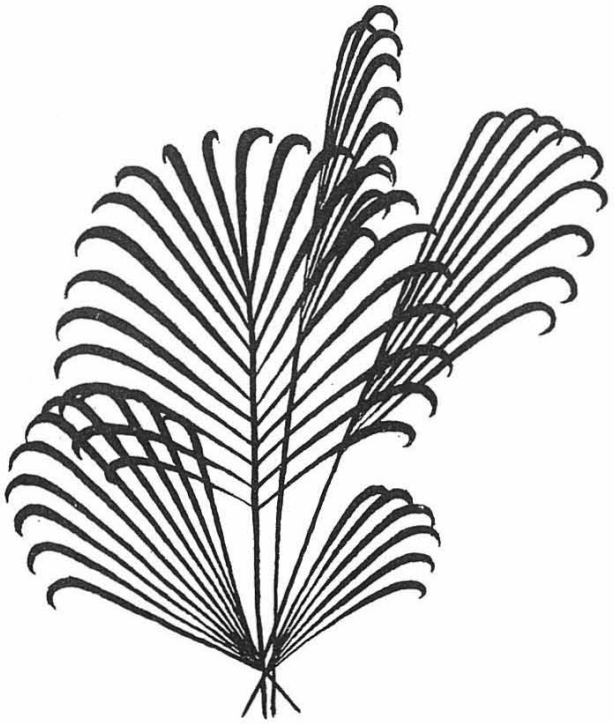
Occasionally some of the local people, who usually live on small coastal farms, would gallop on horseback along the beach. One woman trotted by us grasping reins and an umbrella for shade in one hand, her other arm cradling an infant, who slept blissfully on his real rocking horse.



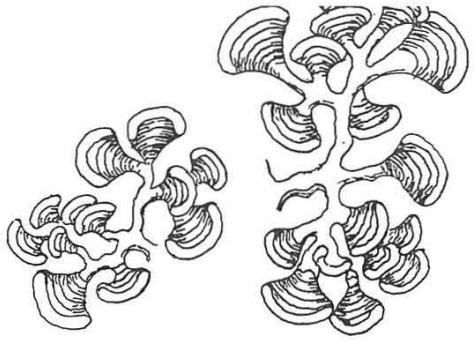
GUANACASTE

The province of Guanacaste is in the northwest, just below the Nicaraguan border and was in fact once a part of Nicaragua. It is cattle country, hot, dry and dusty. We had heard it said several times in other parts of the country that Guanacaste is becoming a desert. Someone reported that the naturalist, Alexander Skutch, had visited there recently and had been horrified at the changes in the last thirty years. Now apparently it takes four and one-half manazanas (8 acres) to support one cow where it used to take only one. So we went off braced for a ravaged environment, and although most of the foreboding reports are true, fell in love.

The rolling tawny hills had a déjà vu quality for all of us, stirring half-forgotten memories of some other place or time. The wind blows constantly through this hot, golden land. The trees are immense with great spreading branches that are the only refuge from the continual sun. At that time some of the trees were blossoming with yellow, pale pink or rose flowers. At night the stars hang bright and low, just out of reach, beyond the branches of the trees. The sense of space and sky that



characterizes so much of the western side of the continent is part of Guanacaste, but there is there a quality of light, particularly at dawn and dusk that has a strange luminous clarity which is unique. Early one morning through the gap of our tent we could see a huge tree outlined against a pale yellow sky. It was alive with dark, moving shapes. Then came the strangled roar of a howler monkey and the day began with their outraged cries.

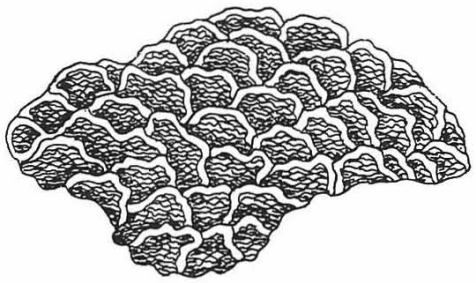


LIMON

Limon is the Atlantic or Caribbean province, extending from the Panamanian border north to Nicaragua. The largest city, Puerto Limon, is the country's major port. There are many old Spanish-style buildings, some with delicate iron work, that have a dilapidated elegance. The central plaza is splendid, like a lush, well-groomed jungle. The atmosphere of the city is the most intensely alive and active of any in Costa Rica. A large proportion of the population is black and most of them speak English as well as Spanish. The rest of the people are Costa Rican Spanish, with a handful of American tourists and a sprinkling of Chinese running restaurants and hotels. The general feeling is hip, gay and uninhibited. We saw people dancing and singing full-volume in the street. The music blaring from an appliance store was a kind of Spanish jazz rock, and one of the children said the music was better here because of the Blacks, which I'm sure was true.

From Puerto Limon we journeyed southward in stages by train, dug-out canoe, and bus to a village called Cahuita. It is a fishing village with several stores, two restaurants, a tiny hotel and poor but pretty houses. The people are mainly black, bilingual, friendly and independent. They are descended largely from the Jamaicans who were brought there to build the railroad. From Cahuita we jolted by truck to Puerto Vargas, our ultimate destination for this leg of the trip.

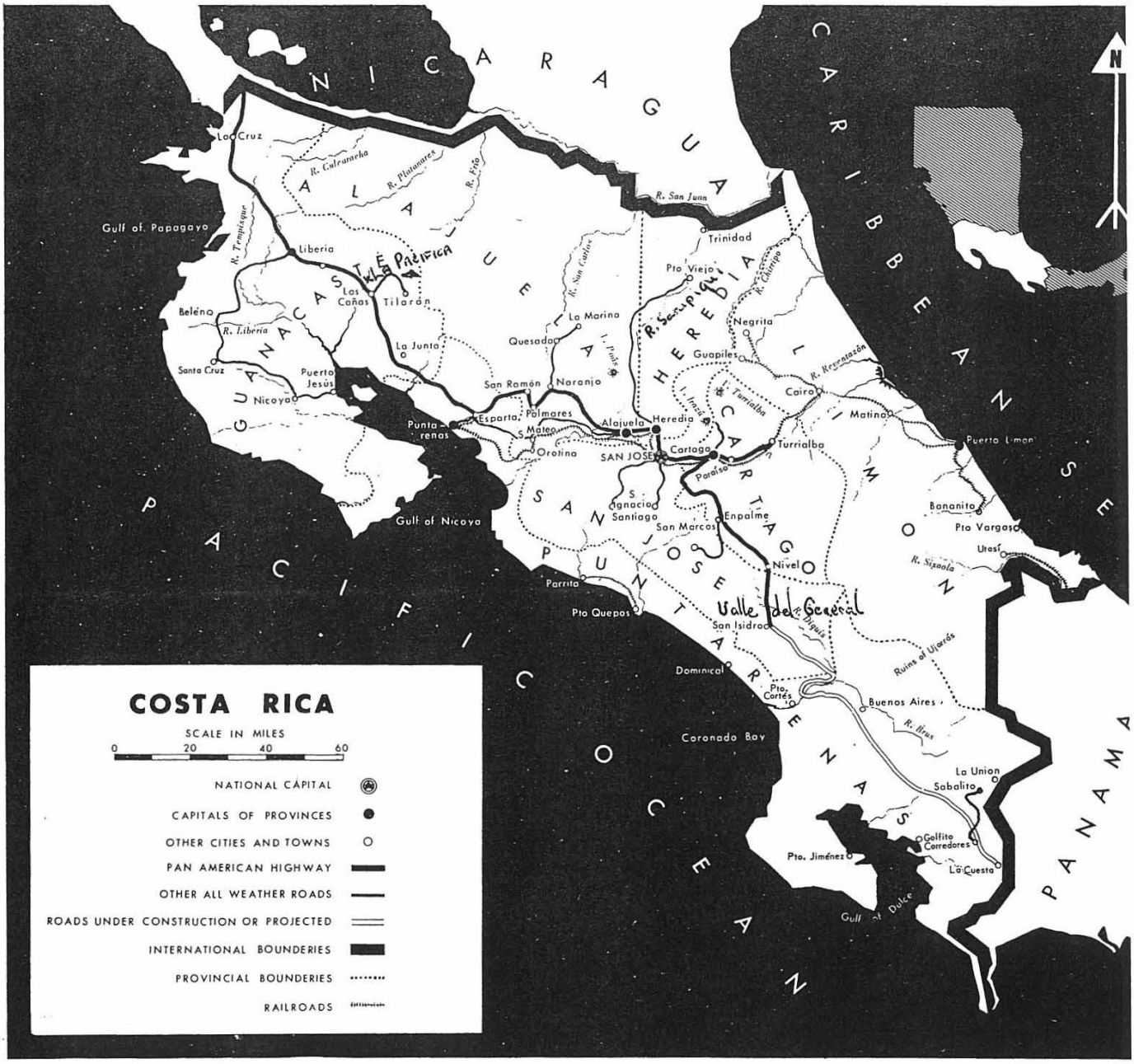
Puerto Vargas consists of one building on a magnificent beach that stretches as far as one can see, perhaps all the way to Panama. Inland are the Talamanca Mountains, where the 6000 or so Indians who have not been assimilated into the dominant culture have retreated. In the

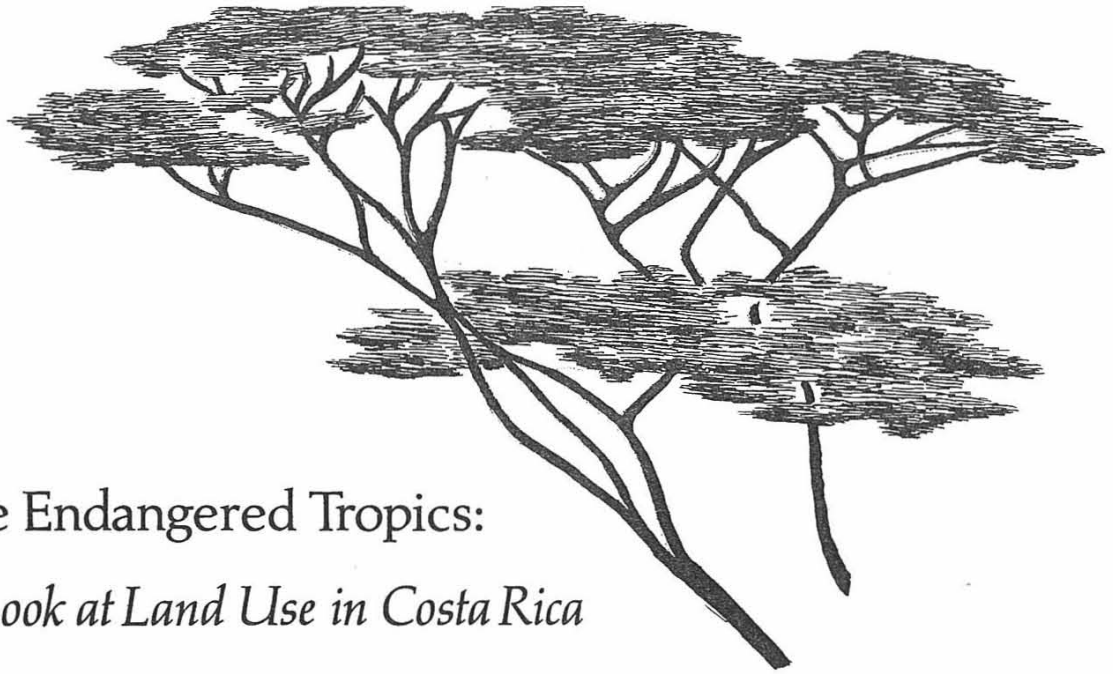


more remote highlands they are still isolated and reportedly hostile. The beach itself could be the archetypical tropical paradise, with a coral reef off-shore that has lobster in its crannies and technicolor fishes flashing by. Coconut palms in a wavering line mark the line between beach and jungle. One can sit on a fallen palm, feet dangling in the water, and see miles of unspoiled coast, or gaze seaward to the reef where the waves break and across the Caribbean beyond. Turning to the jungle above the flowers and shrubs, birds and butterflies dart, sun shafts through shade, monkeys swing and forage, a sloth clings to a vine, squirrels scuttle in the fallen leaves and occasionally a coconut thuds to the ground.

Rumors stir that scent of this lovely place has been caught by American developers. There will be "luxury hotels" one man told me glowingly, "like Miami - and restaurants, tourists, even a jet-port, they say"....

Although we were in the country for most of our time in Costa Rica, with fairly frequent stops in San José en route from one place to another, we did spend a little time in various towns and had some chance to get a feeling for them. Town life in Costa Rica still has a different quality to ours. It is noisy and busy, yet still seems less frantic and more personal. People linger in the streets and in little cafes called pulperias. In the evenings it seems everyone in the town comes to walk in the square, families with children, courting couples and groups of teenagers. Small boys wanting to shine shoes are always underfoot. People talk and laugh and watch each other. The children run and play. There is little feeling that, for these people, the mainstream of life has moved away from the small towns to the city. The pulse still beats in the lighted square, where boys and girls smile at each other and children drift off to sleep on their fathers' shoulders as they turn homeward.





The Endangered Tropics:

A Look at Land Use in Costa Rica

The dynamic of the modern industrial society is gaining a toehold in the tropics and changes are taking place which will put tropical societies in a precarious state during the decades ahead. Costa Rica, an "advanced" modern nation, provides an excellent example of what can and will happen when the forces of industrial societies and their resource demands are unleashed upon a small, primarily agricultural nation. Change is occurring rapidly and Costa Rica's course may be towards a kind of corporate feudalism as insensitive to land as to peoples.

Daily events seem to symbolize what is taking place there: Robert Vesco, an international meddler in the politics and financial matters of nations par excellence, cavorts with many key citizens; lumbermen from the U. S. and Europe scan the remaining forests; huge air freights jet daily to Rome with their cargoes of Brahman cattle; the populace, in the main hooked on technological trivia, transistor radios and the like, believes consumption to be far more important than caring for its lands and protecting its heritage. In this last respect the attitudes of Costa Ricans are like "moderns" everywhere, but here the malaise takes on a more ominous aspect. Their consumption is reflected in a heavy imbalance in trade, which presumably leads to monetary and political favors afforded their creditors, mainly Americans. How much of their politics originate in Washington or in the board rooms of New York is difficult to tell, nevertheless, the likelihood of Costa Rican autonomy being in serious jeopardy is very real.

Costa Rica, a beautiful, bountiful land, may be stepping out on a razor's edge. It is not possible to lay the blame on any specific element present in the society, whether it be consumerism, profiteering, short term perspective, or the insatiable needs of industrial nations for other peoples' plant, animal and mineral resources. All of these factors are involved. The processes are the same as those taking place in temperate societies. The fundamental difference is that Costa Rican environments and the communities they sustain are much more vulnerable, and options for the future are rapidly being reduced. I will return to this point.

One of the things I wanted to do during my last visit was to chronicle some of the changes taking place. Most of my information came from directly observing how Costa Ricans use their land, including the components of industrialized agriculture they have adopted. It was important for me to try to learn to what extent they are users of agricultural chemicals, including pesticides and herbicides, and to what extent their farming involved destructive monocultures. If roadside billboards are any indication of reality, biocides are big business with foreign corporations competing for title of most effective producers of killing substances. Anti-malaria campaigns of earlier years had created a marvelous psychological arena for poison peddlers. A common sign in rural areas, in the schools, public buildings and private houses reads simply "The spray man is your friend".

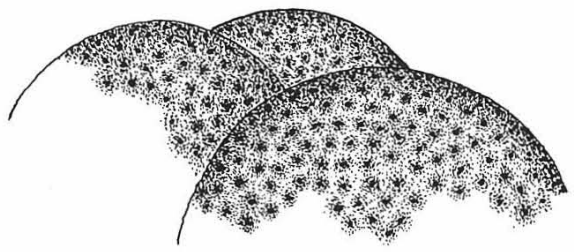
It was not possible for me to find specific facts on either the rates of change or the degree to which Costa Rican landscapes are taking a beating. I don't think this kind of information has been collected. There are some tangibles to grasp about the country; it has one of the world's highest growth rates. Imbalance of payments, deforestation and overgrazing are reflected in exports of lumber and cattle. There are, during the dry season,

water shortages and power blackouts. Fuel shortages are beginning to be considered normal. One trip had to be curtailed part way because we simply couldn't buy fuel in order to proceed.

At this point I want to introduce a bit of an apologia... I do not know the country well. I spent this winter travelling throughout much of the countryside, but it was only my third visit to the country. My impressions are those of a farmer, naturalist-ecologist, with a deep interest in people and their use of the land. What I saw was a country of incredible beauty and great diversity that is changing rapidly. Out of my experience I have come to the conclusion that unless land restoration, along ecological lines, is embarked upon soon and local means are found to effect reconstruction, by the year 2000 Costa Rica will become irreversibly despoiled and her peoples reduced to a state of poverty. The country will be a desert in the west and a quagmire in the east. It will be unable to support its peoples. However, here and there in the wasteland of the western part of the country will be little islands of green.... the resort hamlets of rich Americans who already own much of the land along the Pacific coast. Their lush vegetation will be sustained by artificial and costly means such as desalination plants. The villas of the rich will be shaded and they will have water to drink. Apart from these cases of very dubious merit, the land around will be barren and depopulated.

I don't believe I am being overly dramatic. I obtained several conflicting figures on the extent to which deforestation has taken place. Some ran as high as 70% but this figure was not confirmed. Whatever it is, Guanacaste is basically deforested, the Valle del General is well on the way, the regions to the north and east have had much of their most highly valuable timber removed, and the pace is quickening as the value of lumber skyrockets. Massive deforestation in tropical climates, particularly in moist hot regions, leads to a tremendous drop in the carrying capacity of the land. In fact in a few localities the land has already been abandoned.

Except for scattered visionaries, few people are planting trees. Yet to overlook biological realities is a sure road to ruin for small tropical countries and, unless Costa Ricans take a unique stand and develop, in the very near future, a sense of stewardship their country will lose the ability to sustain itself. Not only will the beauty and the bounty go, but a very fine and humane people will suffer.



TRAVELS THROUGH THE LAND

Nancy Todd has described some of the splendor and feeling of travelling through Costa Rica. Its essences are very real and the land emanates a power that is felt even by people who are untuned to the earth around them.

GUANACASTE: THE NORTHWESTERN PART OF THE COUNTRY

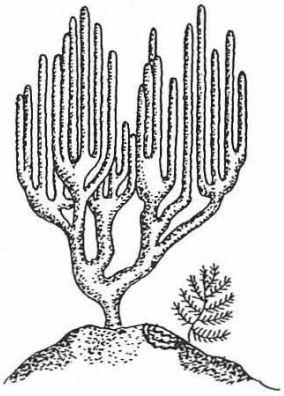
As recently as forty years ago, Guanacaste Province with its long and severe dry season combined with a comparatively rainy wet season still had large areas under forest (1). Since the second world war, as timber and cattle became increasingly valuable, landholders sacrificed almost all of the region's trees except those immediately adjoining the banks of streams. Then they planted pastures which are burned each year at the beginning of the dry season. Great profits were made in lumber and cattle but unfortunately the topsoils have not been able to stand up to the beating resulting from deforestation, heavy grazing and burning. Local ecosystems have lost much of their productivity as the soils, deprived of their humus, can no longer sustain much moisture during the rains. Flash floods are now considered "normal". During the dry seasons the scorching sun exposes the soils to temperatures that are harmful to the wide array of organisms normally present in fertile soils. One cattle rancher told us that in some parts of Guanacaste 4.5 manzanas (approximately 8 acres) is the bare minimum to support one cow.

This winter a drought more severe than normal hit the country. On March 22 I wrote in my diary: "The fall rains didn't come and the meagre grasses are not making it through the dry season. Only one of the African grasses seems to be holding up, but the half-starved animals don't seem to eat it. Off the road west of Cañas we saw dead cattle left where they fell. There was an almost total absence of soil in many places, only rubble and scattered drought-resistant plants. We were told at La Pacifica that it would be two more months before the rains came."

Cotton used to be another major crop but it too was the kind that can wreak havoc upon any environment. A few years ago it was a major crop, but in order to keep ahead of the pest populations characteristic of monocultures in hot climates the farmers were forced to spray parathion and other pesticides 20 to 30 times through the cotton growing season. Finally the point of no return was reached and the farmers were left with their cattle economy. A despoiled landscape supporting a cattle monoculture.

In a few years Guanacaste will be unable to support much more than cactus and sand unless reforestation, soil restoration and an agricultural diversity is introduced into the region. Already there are indications of depopulation taking place although this is not yet reflected in reduced land values. The value of land has remained

high, partly because North American ranchers are still buying land. Lyndon Johnson had a large ranch there and a number of other Texan cattlemen have followed him. High land values have created a state of unreality about the region: The beauty of its hills and mountains nestled close to the sea has attracted many well-to-do who are not dependent upon their ranches to earn a living. The social truth underlying the area may be reflected in the increasing numbers of poorer people away to the cities like San José. I heard that there was at least one area in Guanacaste where people were being forced to leave because they could no longer be supported by agriculture or lumbering. This does not have to happen. There are ways in which the process could be reversed but it will have to happen soon. Sadly enough, I see no likelihood of it happening on its own. Farms like La Pacifica, samples of intelligent and diverse land management, are scarcely emulated despite the signs of troubles ahead. Guanacaste is a cattle culture nearing the end of the line.... a desert in the making.



VALLE DEL GENERAL

Valle Del General, the area surrounding San Isidro, is more lush and rainier than Guanacaste and more recently settled. I did not get to know the area well but during our stay we travelled daily the road over the high hills west of San Isidro to the tiny coastal village of Dominical where I was studying several species of marine fishes. The region was comprised of mixed-crop, hillside farms galloping madly to change and catch up with Guanacaste as a leading cattle area. The land is much newer to monocrop grass farming and the forests have been removed only during the last few decades. Already there are indications that the exposed soils are very vulnerable: On the crests of the steep hills we observed cattle left to forage the coarsest grasses and toughest weeds so characteristic of spent soils.

But to talk of problems ahead there would be close to heresy. Money made in lumbering is being poured into cattle ranching. Ranchers from Guanacaste with an eye on the heavier rains and lush pastures are moving in. Electricity will reach the area next year as a large lake is being constructed as a reservoir for hydro-electric power. There is talk of a huge beef processing complex and people are moving in in droves. There has been a 10-fold increase in population over the last thirty years and the process has only just begun. The government has built schools and a hospital and the region is acquiring a modern image.

Excitement is high, pure frontier, yet the boom will be short-lived. It was here that I felt the fragility of the land most strongly and at the same time I became most conscious of the land as the key to long term biological stability as well as social richness and health. This "other reality" has been chronicled by Alexander Skutch in his "A Naturalist in Costa Rica" (2). For the past forty years he has participated in the life of the valley, as well as pursued his scientific studies of the plants and bird life of the region. To read his chapter "Vicissitudes of a Valley" is to look deep into the eye of a storm that is brewing. There are the "hard facts". The list of wild animals that have gone, the birds that no longer inhabit the forests, the replacement of perennial crops including coffee on the steep hillsides with cattle. There are descriptions of deforestation on the most abrupt slopes replaced by pasture which is played out in a few short years.

A flight into night....all in a moment in time.

But these aren't the only agonies of the region. Dr. Skutch set out to preserve a small piece of forest on his farm. Not only were the game poached but some of his trees were stolen too. Tall palmettos and chonta palms containing the coveted hearts of palm were the special targets of thieves. In the end he was forced to hide his banana plantation deep in the woods in order to salvage his crop.

Skutch places the population explosion at the root of the crises facing Costa Rica and he may be right. However, it might be possible for the valley to support its present population if, and only if, economic realities were based upon strict ecological ones. At the present, the name of the game is multipronged rape; exploitation, deforestation, monocropping and overgrazing. The vision is limited to today - tomorrow is another matter.

Processes which take a century in temperate regions are acted out in a few years in this beautiful, vulnerable country. The needs of the original ecosystem have not been met. The thin soils are exposed to leaching, burning and the incredible heat of the sun. When the soils are played out a farmer must continue to burn the remaining vegetation in order to release enough minerals for new plant growth. Each time he does so there are more losses in the cycle and the reservoirs of precious nutrients are lost to the atmosphere and to the sea. The fertility of the region that was once locked up in its trees is almost gone. When will men learn that an area's destiny is tied to its soils. In the humid tropics this truth is magnified, yet it has failed to capture the imaginations of the people who live there.

SARAPIQUI: ATLANTIC TROPICAL WET FOREST

Sarapiqui, the region bordering the Rio Sarapiqui, has a special meaning for a number of New Alchemists. Bob Hunter, a scientist-farmer, has worked the land there for almost two decades on his farm, *Granjas Tropicales.* Bill McLarney was lured to the region by its rain forests, biological diversity and the intriguing fishes which are found in the streams flowing into the Caribbean. This past winter Bill and Bob Hunter began construction of the first of a series of fish ponds in order to test some of their ideas in tropical fish culture. It was in this region that New Alchemy attempted to buy an experimental farm, but we were outbid and no new sites have been found.

In many respects Sarapiqui has an air of raw frontier. Roads are being cut into the forests and equally quickly logs are being hauled out. The drive there is a primary experience in avoiding careening logging trucks with their cargoes of felled giants.

Sarapiqui is wet, as much as 160 inches a year fall on the region, mainly during the May-December rainy season. One is awed by the huge trees and forests which are disappearing. When the earth's tree mantle is finally removed over the next few years it is not likely that the land will support much in the way of human endeavor.

The future beyond tomorrow is not much on people's minds. Sarapiqui and the adjoining regions are in the midst of a boom. A few years ago when I first was introduced to the area, small farms were prevalent and there seemed to be some diversity of crops. But the scenario is changing. The region has been discovered and the forests are being turned into grass for cattle. Everybody is involved, small Costa Rican farmers, ranchers from all over, North American lumbermen and big time Gringo entrepreneurs. The area is relatively remote, yet New Alchemy when trying to acquire a piece of land for an ecological farming research center was outbid by a group that included the owner of a large U. S. grocery store chain.

The aim of landowners seems to be quite simple: log, raise beef for a few years until the land is exhausted and then pull out for greener pastures. It is the antithesis of an ethics of permanence.

A region which receives so much rain cannot cope with this kind of treatment for long. It needs a fair amount of forest to act as a sponge to prevent the soils from being washed into the sea. It is hard to comprehend the impact of the rains without feeling it. At Puerto Viejo, the lower farm at *Granjas Tropicales,* the river rises and falls over a range greater than twenty feet.

The area can only remain productive and support a human population if the farms there are primarily based upon a permanent or tree crop agriculture. But farms based upon tree crops are few and far between. The best example of a permanent agriculture is the farm *Granjas Tropicales,* where a great variety of trees and vines are cultured: rubber *(Hevea brasiliensis),* cocoa *(Theobroma cacao),* pejibaye palm *(Guilielma gasipaes),* citrus *(Citrus spp.),* guava *(Psidium guajava),* African oil palm *(Elaeis guineensis),* achiote (scientific name not known), Macadamia nut *(Macadamia ternifolia),* passion fruit *(Passiflora edulis),* bananas *(Musa spp.),* plantain *Musa paradisiaca),* breadfruit *(Artocarpus communis),* black pepper *(Piper nigrum)* and the root crops, cassava =yuca or manioc *(Manihot utilissima)* and Malenga= dasheen or taro *(Colocasia esculenta).*

There are no doubt several other crops I have overlooked. Another important aspect of the farming at *Granjas Tropicales* is the variety of interplanting of crops. In some instances one crop is planted to help prepare the ground or to act as shade for a following crop which takes longer to mature. Certainly there are serious attempts to work with nature and where possible to apply basic principles of ecological succession which is the maturation through time of an ecosystem growing towards more stable and diverse states.

Yet *Granjas Tropicales* does not seem to be having any significant impact on all over farming methods in Saraqiqui. There are a number of reasons why this is so: the farm may be too big to be comprehensible to the average farmer. So much labor, machinery, capital and organization; so much knowledge of trees, soils, climate, and so forth is required to orchestrate the whole complex. In short it's easier and simpler to run a grass and cattle farm and the payoff comes much sooner. Nevertheless, the biological farm does support a fairly stable human community, a school and a store. Much of the labor is carried out under the shade canopy of trees except in the groves of black pepper and passion fruit. These more human values don't really seem to carry much weight with most Sarapiqui cattle men.

Granjas Tropicales is an island of sanity and diversity in the humid lowlands of Costa Rica, lowlands which are rapidly being overrun by herbaceous weeds as the shallow soils are exposed to the direct rays of the sun and to the pounding rains. But the time may be fast approaching when neighboring farms will be too far gone to emulate the more land-restorative approaches of Robert Hunter's tropical orchards.

There is a truism which needs articulation and expression in a variety of ways so that its meaning permeates into the consciousness of those who hope and would create societies within nature's framework. Despoilation need not be the norm in Costa Rica or in any other segment of the world. A few tropical peoples are wiser and their communities are sustained by a sophisticated swiddening gardening which I will outline later. They follow the patterns of nature closely and by doing so they are able to support populations as dense as those found in industrial societies, and they do this without degrading the forests or the places where they live. Their genius should be a guide to those of us desirous of shaping somewhat autonomous, local ecosystems which can restore abused lands. (3)

AN ECOLOGICAL PERSPECTIVE OF THE TROPICS

The negative views I have presented in describing Costa Rica have their roots not just in the observations that were made, but also were gleaned from tropical ecologists. As more is learned about tropical ecosystems and their strategies, it becomes increasingly possible to view the future by reading the present well. Tropical environments are extremely vulnerable.

Many tropical lands in Africa and Southern India have lost much of their ability to support human populations and a great diversity of plant and animal life. These historical examples were not regions exposed to the recent blight of advanced industrial nations which comb the world for other people's resources.

Exploitation drives environments and ecosystems back to simpler, more vulnerable states (4). This backwards shift is most prevalent in the more diverse and productive regions of the world, such as the tropical rainforests. Indigenous plants are destroyed for lumber to be replaced with one or a few crops. While the process leads to degradation in temperate regions (5) in the tropics the situation rapidly becomes extreme and precarious (6). It is not just the plants that are affected. Stressed environments may eliminate some of the most highly evolved animals by eliminating their niches, or by directly interfering with their normal social organization (7).

Plants in tropical monocultures have severe difficulties coping with pest organisms. Monocultures dictate that plants of the same varieties be close together making them easy targets for pests. In wild tropical environments one of the basic plant defenses against insects is a varied and diverse spacing with any given plant association. Most plants of the same type are strategically separated in space (8).

When agriculture is industrialized and mechanized and lands are planted to single crops, other biological stresses are introduced into the system. The relationship between beneficial insects and the pests they prey upon breaks down. Without a diversity of habitats, the beneficial insects are deprived of a suitable "home" and they can no longer keep pests from proliferating. The problem is compounded, in the humid tropics especially, because the farmer lacks dramatic changes in weather that would limit outbreaks of herbivorous insects. For the northern farmer winter aids in keeping harmful insects at bay.

There is also a much more rapid loss of soil fertility in the tropics. When forests are denuded and replaced with cash crops the soils (the fertile zone is often less than 2" in depth in the first place) are washed away in very short order. Dr. Janzen, a tropical ecologist, has explained the problem well (6).

"When tropical vegetation is cleared, high soil temperatures and rainfall lead to an almost immediate removal of inorganic nutrients released from the dead plants. At best the remedy of fertilizers, intelligent methods of clearing and promotion of microrhizal associations makes the new field an adequate substitute for growing crops. It does not guarantee a crop sufficient to compensate for the total cost of its production."

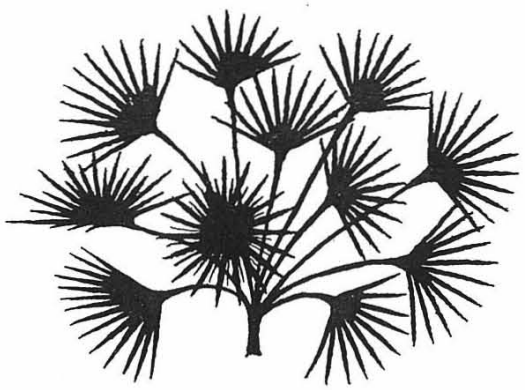
He then goes on to state that after 1-3 years the carrying capacity of tropical fields declines drastically and more fertilizer only aggravates the problem.

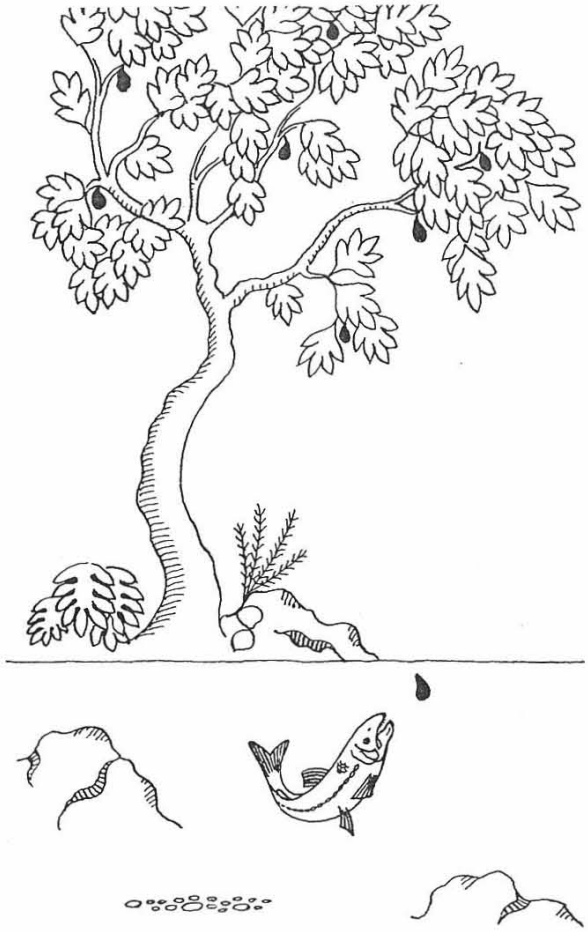
Tropical monocrop farms also have to cope with the fact that weed problems are much increased in tropical fields. The weeds, unlike the crops cultivated commercially, have an intrinsic ability to repel crop pests because they are able to produce poisons or defensive chemicals like strychnine in their tissues which keep pests from devouring them. Shade, created by canopies of the trees, is a major check against weed growth in the tropics. However, it is removed when the forests are destroyed.

Pests, weeds and problems of soil's fertility are greatly exaggerated in the tropics. Further the chances of biological controls like those being developed against temperate region pests are unlikely to work in large tropical monocultures because of the greater diversity of response strategies open to troublesome insects (6). This host of problems has been combated by the farmers and ranchers in recent years by the use of insane amounts of pesticides, herbicides and fertilizers.... a practice which mainly benefits foreign manufacturers far removed from the mounting problems they are creating. Heavy poisoning of tropical landscapes will, in the end, destroy most of their ability to restore themselves.

On first viewing, the present situation seems hopeless and worsening with no alternatives on the horizon. But a deeper probing suggests that it might still be possible to harness some of the productivity of the tropics so that civilized societies might be sustained in equatorial regions. I must add that I am making this statement cautiously knowing that mankind is under terrible pressure to recapture enough wisdom to alter the course of a failing planet.

Tropical realities are two-edged.... there is the abyss which we have covered, but at the same time there are beacons which light up on the other side. If we work close to and with nature some incredible potentialities rise up to challenge us and guide us.





Restoration and Reconstruction in Costa Rica: *Some Possibilities*

"Build the old waste places.....
raise up the foundations of many
generations.....
be called, The repairer of the breach,
The restorer of paths to dwell in"
– (Isaiah 58:12)

JOSÉ ARIAS RODRIGUEZ
A STEWARD OF THE EARTH

I have often pondered why good farms like *La Pacifica* and *Granjas Tropicales* have had relatively little influence in Costa Rica, whereas the impact of Louis Bromfield's Malabar Farm has reached into the far corners of the earth. Communication is part of the answer, but then why does one man try and reach outward to share his experiences and failures?

To answer this question in Costa Rican terms is difficult. The intractability of the cattle culture is part of the explanation, but certainly not all of it. I did not find an active program at the two large commercial farms to disseminate their information, improved varieties of plants, expertise or tactics into the larger Costa Rican agricultural community around them. Both are "foreign" farms (one Swiss and the other American) and there may be a calculated desire to maintain a low profile in their adopted country. They are also first and foremost businesses with the primary goal of earning profits, and profits are often tied to the relative market scarcity of the crops they sell. The competitive-exclusion principle may tend to keep new and more successful ways of farming from spreading outward. There is also the very real possibility that the people running the farms are just too busy to have time to develop cooperative programs with their neighbors. Whatever the explanation.... and I suspect all these factors are involved, the word is not getting out and these excellent farms remain oases in an increasingly blighted landscape.

However, I met an incredible man, José Arias Rodriguez, who symbolizes for me what an earth steward

must mean if there is to be any hope for tomorrow. Don José crafts landscapes which restore and which are supportive through his trees. He is primarily guided by a humanitarian desire to make the earth a responsive mother for his countrymen. An old man now, he works with a few assistants in his nursery and orchards struggling hard so that fine trees will be available to those who understand the full meaning and potential of tree crops. He is a writer so that his ideas may have wings. Eagerly he spreads the details of all that he has learned so that others can follow. His latest book entitled "Fruticultura Tropical" is written in Spanish and is a sound and comprehensible guide to culturing trees in the tropics (9).

Like most men of vision Don José seems to have reached backward to pioneers of earlier times for inspiration and direction. He is a staunch disciple of Sir Albert Howard. One immediately notices the compost heaps throughout the orchard and he explained that in the tropics composting becomes critical to the sustained success of tree crops. For some forty years he has been breeding and raising trees and one new variety of citrus (the Rio Segundo mandarin) was created on his tiny farm. To walk through the farm was a profound experience for me. Don José talking in his personal rage against the destruction of the countryside of Costa Rica. Juxtaposed against his vital anger and desire to right wrongs was his nursery with thousands of tiny trees spread amongst the orchard. I could feel his humor when he saw me gaping at a bearing apple tree growing next to an orange ripe with fruit.

Several large trees in the middle of the garden were archetypes of the wisdom of his mission to reforest the land partially with a diversity of food trees. Standing out most prominently were two mango trees (*Mangifera indica)* which he had planted forty years ago. At their bases were compost heaps which he explained were the basis for the health and incredible productivity of the trees. Because of their health he rarely has to spray them, while other mango growers spray weekly against insects, especially the Mediterranean fruit fly and against fungus which attacks during the long ripening period of the fruits.

As he talked about the trees I attempted some crude calculations on just what those trees might represent in economic and ultimately social terms. Mangos, like avocados, are a valuable crop in Costa Rica, even at their source. His two large trees combined produce approximately 10,000 mangos a year. The labor involved in caring for them in a diverse orchard is not great, yet their value is high. Properly marketed, the fruits of the two big trees like the ones in the garden might represent a decent annual income for a relatively self-sufficient farm family in Costa Rica. I began to see the potential of Señor Arias and his trees. Fortunately for Costa Rica, some people are listening to him and his young trees are in great demand. The ideals that he stands for are becoming appreciated and young American organic farmers in Costa Rica visit him frequently for his skills and trees. The tiny farm is becoming a minor mecca. While we were still in the country, a major newspaper sympathetically described his efforts to articulate and promote a land ethic for Costa Rica.

Restoration in Guanacaste Province: *Prospects for Arid Lands*

The great contrast in the climate of Guanacaste plays havoc on the land once it has been deforested. The climate naturally varies from torrential rains during the wet season to weather that is blisteringly hot and arid during the long dry season.

Since Guanacaste was deforested, flash floods, extremely strong winds and beating sun have resulted in the loss of the basic fertility of the parched soils. In order to restore this region it will be necessary to stabilize some of the impact of the extreme oscillations by tempering the winds, arresting the flash floods near their sources and returning the nutrients to the soils. Much of the area will need to be replanted to trees.

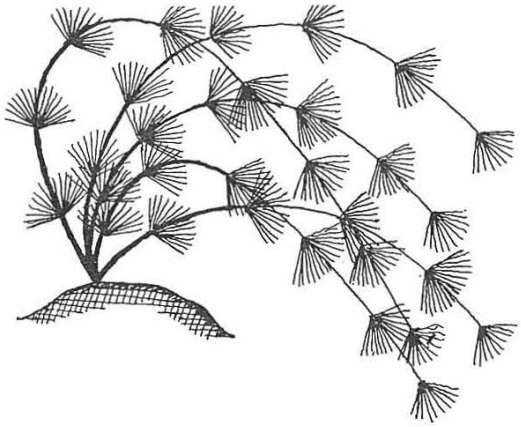
This is not an impossible challenge. A restoration scheme such as I am proposing would work best at the basic social unit, namely the individual farm. Further, a shift to a form of farming derived from ecological strategies could evolve out of existing cattle operations and there would be a place for cattle on the farms of the future. However, they would be one component out of many and they would not dominate the new farms either ecologically or economically as the farms are developed towards a more mature, stable state. The total carrying capacity of the lands would be greatly increased. Despite the diminution of the relative status of the cow on the ecological farms, in the future each individual farm could possibly sustain comparable numbers to those presently found there.

The strategy for restoration I am proposing can be briefly introduced as follows: The extreme oscillations in availability of water and the flooding could be controlled by terraced wadis, small dams and large ponds fitted to the local topography. In this way water and soils normally lost to the area would be retained. Recently discovered biological techniques may make it possible to construct ponds that will hold water even in porous soils. The ponds, enriched by animal manures, could be developed into extremely productive polyculture fish-rearing systems and the highly fertile pond water, in turn, could be released to tree crops and pastures during the dry season either through wind pumps or via ditches and aqueducts. The pond cycle can be very productive and is the key first step in restoring productive regions in arid zones. The ponds might not only permit the growth of large amounts of fishes, but pond water could also act as an important soil improvement technique by fertilizing as well as irrigating the crops. At least in the early stages this might be a critical stage in successful biological farming.

But this is not the whole task. The powerful winds which during the dry season dehydrate and blow away the top soils will need to be ameliorated by reforestation. On each farm the periphery and the hill tops should be permitted to return to wild forests which will break the winds and provide a diverse biological base. Towards the interior of the farm, meadows, pastures, ponds, tree crops and gardens should increasingly predominate. With careful planning to reduce winds in the interior, tree crops, like avocados, which now set fruit badly, or not at all, in Guanacaste because of high winds might be grown successfully. Interestingly, as the complexity of each farm increases the numbers of people needed to care for the land will grow proportionately and many people will probably decide to return from the cities to help tend the crops. Rural communities might be revived throughout the region.

Instead of beating sun and driving, dusty winds, there could be shade and moisture, and cooling breezes under the tree canopies. The rains could be enriched and stored for use during the dry season. New food chains will suggest themselves: Pond systems.... herbivorous, omnivorous and carnivorous fishes, freshwater shrimps, edible aquatic plants and perhaps even in some cases paddy rice could be grown. With water from the ponds, grasses, legumes, grains, fruit orchards, nut groves and high quality timber stands could be irrigated. Gardens, some situated in drained ponds, could be filled with a variety of vegetables, herbs and spices. Ducks, geese and chickens could be fed on the by-products and waste products. Cattle could be provided with shade and maintained on diverse pastures. As each cycle is increasingly linked over time, the productivity and self-sufficiency of each whole farm ecosystem should also climb. At the same time the cost of supporting individual farm residents would be reduced.

None of the tactics for land restoration that I am recommending be tried in Guanacaste are unique in themselves. Rain water runoff and control has been perfected in Israel, the pond cultures have been highly developed in parts of the Orient, and from Russia new information exists which could well permit water to be stored inexpensively. The importance of wild land reserves for a balanced agriculture is indicated from modern ecological studies, and the possible linkages between ponds and food crops from early New Alchemy investigations. The horticultural and forest sciences have a lot to contribute to our understanding of caring for food and timber crops. It is in the assembling of the components from very specialized disciplines into bountiful wholes that will take genius, patience and lots of plain, hard work. Here I can give only the broadest, most introductory outline of how it might be possible to make the land and its peoples flourish in Guanacaste. I intend my comments to be only the most general guides to the future.



RESTORATION BEGINS WITH THE CONTROL OF WATER AND THE BUILDING OF PONDS

The Control of Runoff

Several thousand years ago inhabitants of the Negev desert in Israel farmed using a sophisticated runoff agriculture. Villages, towns and commerce thrived because of their farming skills. How they managed to achieve the impossible and to grow in the desert fruits, wine grapes, grains, nuts and herbs described in the ancient manuscripts has remained a mystery for centuries.

The discovery of the lost desert farming techniques was made by a small group of scientists within the past few decades and their story chronicled in the book "The Negev: The Challenge of the Desert" is as incredible as it is important(10). My ideas for the control and use of runoff water in Guanacaste are primarily derived from them, and I urge those who are working in arid lands everywhere to study their book. Desert isolation forced the small band of scientists to be wholistic and basically ecological in their approaches to the land. The guiding hand of the ancients indicated that the solutions to the mysteries would come from an intimate association of the subtleties of desert ecosystems. For the desert dwellers, the simplest system they devised for capturing and using the brief and infrequent rains was through the terracing of wadis or channels of watercourses which are dry except during periods of rainfall. The low stone terraces slowed the course of the water, permitting it to sink downward into the soil. Equally important, the rich silts were prevented from being washed out of the area. Behind the terraces many of their crops, including grains, were sown.

Besides the wadis, on the more sophisticated farms with larger populations, the hillsides were terraced so that they would act as large catchments during flash floods. The terraces in these instances functioned as conduits and the whole hill provided water for irrigating bottom lands or for storage in cisterns. In the water-poor Negev desert the area of catchment to the area of cultivated fields was about 20:1. The movement of the silt in the runoff water to the crops must have played an important role in sustaining fertility.

Guanacaste is not the Negev by any stretch of imagination, nevertheless, the problems of gathering and directing water in large amounts during the rainy season are very similar. Water must be stored for the dry season and soil fertility must somehow be sustained. In order to do this water management should begin at the top of each microcatchment area just as is the case in the desert. One farm I looked at closely near Santa Cruz had steep upper slopes and the erosion had become so severe that only a few hundred feet from the hill tops the land was gutted with steep ravines. On this farm the only means of restoring it properly would be to build a series of tiny dams near the upper reaches and to lead the excess water into larger catchment areas in the fields below.

The crucial needs for water control are: 1. To avoid losing most of the water to the region; 2. To catch the soils being washed away close to their source; 3. To provide water for ponds which could be the key to restoration and soil enrichment in areas where rain is sparse or nonexistent for a large part of the year. Water storage in large ponds can provide a critical and novel approach to dry land restoration, especially in the tropics.

The Ponds

Rarely have ponds been used for water storage, silt entrapment, irrigation and aquaculture throughout the arid regions of the world for a very basic reason; namely that most desert and despoiled soils do not hold water well. In fact many such regions are characterized by stony and sandy soils. In the main Guanacaste soils appear to be ill-suited for water reservoirs. However, there may be a solution.

Very recently two Russian scientists may have found a possible answer to making porous soils impermeable to water through a study of the biological processes which take place in bogs. Bogs are ideal reservoirs because the stagnant water bottom soil complex called gley is impermeable. On the bog bottom the growth of anaerobic bacteria and the decay of plants without access to oxygen produces changes in the structure of the soil, and the ground becomes less porous. Apparently it turns greenish and blueish-grey and becomes a structureless, water-proof "plastic" mass.

The Russians were able to produce artificially bog conditions in the following way: "A layer of vegetation is spread by bulldozers on the soil surface. The best thing to use is dry vegetable matter rich in cellulose: straw, hay, weeds, potato and beet haulm, hemp waste, reed leaves and spoiled silage. The average is 6 or 8 pounds a square meter. The vegetation layer is then covered with a 6 to 8 inch protective layer of earth. Then the water is let in.

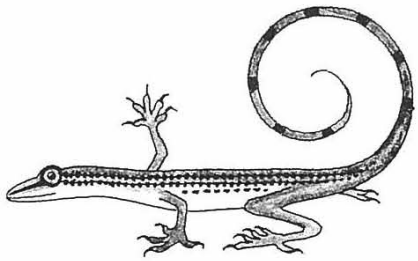
In this laminated screen, the vegetation serves as a source for the development and vital activity of anaerobic bacteria, which create the water-impermeable layer" (11).

Their discoveries, as yet little appreciated, could turn out to be one of the most beneficial findings of modern biology. They may have placed in our hands an incredible new tool that requires little in the way of capital. However, the "universality" of their findings are far from clear and it will be necessary to carry out research in Guanacaste to test if indigenous soils can be made impermeable. As yet there is no assurance that "bogs" can be established that will hold water through the dry season in Guanacaste.

Variations on the Russian experiments should be tried. One possible experiment might be to sow grasses densely on the empty dug ponds at the onset of the rains. About half way through the rainy season, when the grasses are well established, they could be mowed and the grasses be allowed to remain where they fall. Then the earth layer could be added, hopefully leaving enough time for the pond to be filled before the onset of the dry season. Several plantings and new earth layers might be required before the ponds are suitably sealed.

Ponds for the Rearing of Aquatic Animals

There is an incredible potential for the pond culture of fishes and other aquatic animals and plants in tropical climates. To overlook aquaculture would be tantamount to by-passing one of the most effective ways of coping with protein shortages in equatorial lands. In ponds it is possible to take advantage of three-dimensional space and the efficient ability of fishes and other animals to convert algae and microorganisms into edible and nutritionally valuable meat protein.



Oriental polyculturists (those who farm several species within a single pond) are able to raise as much as 8000 kg/ha (which is roughly equivalent in pounds per acre) utilizing relatively simple techniques and requiring only readily available feeds and fertilizers (12).

Certain Malaysian farms provide an interesting, more complex and productive variation on this theme. The pond becomes the key component on small self-sufficient fish-pig-plant farms; Ditches carry the manure from the pigs to the ponds. *Tilapia* and Chinese carp feed on the algae and small invertebrates which thrive in the fertile ponds. Aquatic vegetables *(Ipomoea repens)* are also grown with the fish and are harvested (hundreds of kilos daily) to feed the pigs. On a 4.4 hectare farm (approximately 10.5 acres) 3000 kgs (6600 lbs) of fish and

30,000 (66,000 lbs) of pig meat are produced annually (13). The pond in the Malaysian system provides many of the primary inputs into the farm.

The New Alchemists have begun a search for Latin American analogs to the Chinese and Malaysian systems. In South and Central America there exists a rich diversity of fishes which have been little explored for pond culture. This is particularly unfortunate, as the peoples of Central America enjoy eating fish when it is available.

Bill McLarney has recently embarked upon the lengthy task of studying Costa Rican fishes that might be suited to culturing and his first report is described in the Aquaculture section of this issue. In future issues of the JOURNAL he will continue to explore the ideas and describe the research which may lead to analogs of oriental pond cultures using native fishes in Latin America. Support for this work is being sought.

At this point I am going to propose a hypothetical polyculture scheme for Guanacaste that utilizes several native animals and one exotic already introduced for culture purposes into Costa Rica. A possible line-up is as follows: *Tilapia spp.* is the exotic in the system. Some species of *Tilapia* feed upon microscopic algae while others prefer pond plants, and all species are primarily herbivores feeding low on the food chain. The second genus of fishes that might be adaptable to pond culture is the omnivorous machaca (*Brycon sp.*) described by Bill McLarney.

Also there are catfish of the genus *Rhamdia spp.* which grow to edible size in the slower reaches of Guanacaste streams and they could well occupy a vacant niche in the polyculture ponds. Not to be overlooked is the freshwater shrimp (*Macrobrachium sp.*) which also grows to a considerable size in Guanacaste. At night the lights of shrimp fishermen can be seen as they cruise up and down the streams searching for this much-cherished animal. Shrimp command high prices.

Apart from the *Tilapia,* little is known about the potential of the fishes mentioned above and there may be others far more suitable. The culture of freshwater shrimp is still in the experimental stages, but research on the rearing of *Macrobrachium* is now going on in the Pacific and other parts of the world.

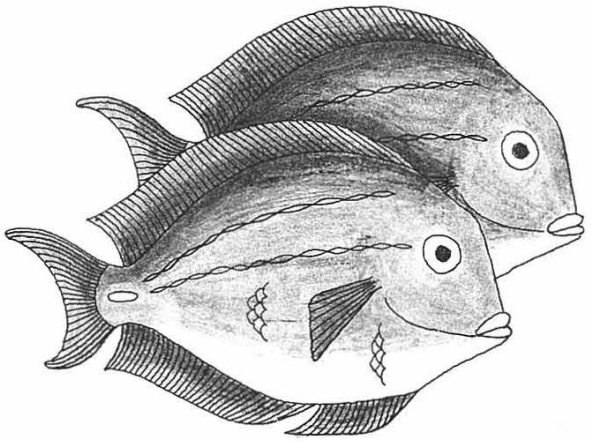
With some support and a few years of dedicated and patient study it is my contention that highly productive aquafarms could become operational in Guanacaste and other regions of Costa Rica. Such farms would provide an essential link in the reconstruction of this beautiful region.

Polyculture Ponds as a Substrate for Intensive Gardens

It should be possible to devise crop rotation schemes to take advantage of the rich pond muck produced from the fish and crustacea waste products and from the remains of algae and zooplankton (microscopic aquatic animals). If the ponds were drained for irrigation purposes after the fish were harvested, then a fertile weed and pest-free bed would be available for the intensive gardening of valuable market crops.

Polyculture Ponds for Irrigation and Fertilization

During the drier periods of the year the ponds could play a primary role in water management on Guanacaste farms. The water would be much needed for livestock and irrigation. Water could be transported by pipes, aqueducts and ditches or pumped by windmills to the pastures, gardens and tree crops. The strong winds of the area during the dry season favor the use of wind-driven systems in the flatter terrain, while along the hillsides the more traditional ditches might prove entirely adequate for the transport of water.



There is good reason to suspect that the pond waters will also add to the fertility and productivity of the soil. The water filled with dense blooms of algae, microscopic animals and their nitrogenous waste products could well act as a liquid fertilizer, especially if the polyculture ponds have been previously enriched by cattle, hog and fowl manures. A few years ago I carried out a small experiment growing parsley and lettuce under the dry conditions found in my laboratory office during the winter. Plants irrigated with water from aquaria with a high density of fishes grew faster and were larger than those grown with tap water. Bill McLarney's field trials with lettuce on Cape Cod are yielding similar results. In arid areas the fertilizing effect of the water from polyculture ponds might prove important for some crops.

Reforestation

The borders and hilltops of the ecologically-derived farms should be allowed to return to natural forests in order to stabilize internal climates and to make the farms more complete ecologically and economically. The advantages of reforestation are many. Forests break the strong winds and provide a diverse variety of plants and animals including insectivorous birds and predatory insects, which in their turn could help to keep pest popu-

lations in check. No doubt the wild forests will also house nuisance animals capable of damaging crops; however, their control might best be effected by separating the woods from the fruit and nut groves and vegetable crops by pastures and meadows. The forests might not only add to the biological stability of the farms, but they could within a few decades increasingly provide a new source of income from the selective cutting and sustained management of timber. The farms would have a continuous source of building materials and a cash crop if the woods are managed wisely. Wood as fuel is still important in Costa Rica and with petroleum shortages already a reality there, woodlots could stabilize somewhat self-sufficient farming regions by providing wood for cooking and also for the manufacture of wood alcohol for machinery that could not be run from wind-driven generators.

The forests then can be seen as another vital link in the restoration of regions like Guanacaste. They will act as windbreaks, captors of moisture, holders of the precious soils, sources of biological diversity, havens from the heat for grazing animals, sources of lumber and wood fuel, and as a home for increasingly beleaguered wildlife. Even in the tropics, reforestation, because of the time involved for a woods to become established, requires a prodigious commitment to the future, perhaps even beyond the lifetimes of many of us. But there is no meaningful alternative to this commitment and hopefully it will flourish in Costa Rica.

Stewardship and Land Restoration in the Humid Tropics

The Atlantic slope of Costa Rica, including the Rio Sarapiqui region described previously, is threatened. The agriculture and forestry of the area are primarily exploitive: forests are felled en masse for timber then the exposed areas are planted to grasses for the raising of cattle. The soils, when used as pastures, are exposed to the high temperatures and to an inordinate amount of leaching from the torrential rains, so that within a few brief years the land loses its productivity and sustains only the coarsest grasses and herbacious plants.

The exploiters for their part usually profit well from the stored fertility of the land accumulated over decades or centuries. Having withdrawn the biological capital of the region, they then move on to remaining forested regions to repeat their rapine acts upon the landscapes of the humid tropics. This is the predominant mode of land use and it represents a form of agricultural imperialism which threatens the poorer peoples who settled in these potentially bountiful regions.

But there is an alternative to the misuse of land in the humid tropics. The knowledge and techniques exist that would permit wise modes of farming a diverse array of foods while maintaining soil fertility, perhaps indefinitely. The basis for an alternative tropical agriculture is swiddening, a method of land use which evolved independently many millenia ago throughout the world's tropics. Swiddening, actually a form of gardening, has supported a great variety of human societies until modern times and the principles employed may well hold the key to the future in the wet tropics of the Americas. Modern analogs of swiddening need to be created which also incorporate some of the best findings of ecology and the forestry and agricultural sciences and new tools must be designed for unique conditions created by these analogs. If this came about, there would be a rebirth of societies highly adapted to the wet tropics. An agriculture with its origins in swiddening may perhaps be the only path for the future. It would be deeply rooted in the finest methods of the past but it would not be limited by them. We know that brilliant civilizations once flourished in the lowlands near the equator. The Mayans, for example, wrought elaborate and beautiful monoliths, sculptures and buildings and their triumph was no accident or quirk of nature. For centuries they must have farmed well, carefully heeding the processes of nature herself, and by so doing they had the health and desire to bequeath their mark upon the world.

I have wondered if the decline of the Mayan civilizations was at least in part a result of their societies becoming rigidly stratified. In the end their rulers and priests were no longer close to the soil, so they lost their direct involvement with the forces which sustained them. Decisions were made which were in conflict with nature because they no longer felt her.

SWIDDENING: A PRACTICAL AND CONCEPTUAL GUIDE TO LAND USE

Swiddening is often erroneously considered one of the crudest forms of farming, practiced by the most primitive of peoples. It is equated with cutting and burning of trees for the preparation of the land for crops. This is true but swiddening goes much deeper for in recent times it has been learned that it is one of the most subtle methods of raising foods. Its practitioners have a profound appreciation of the nature of the forest ecosystem to the point where their gardens have a structural similarity to the rainforests which surround them. Swiddening is a form of gardening which uses three-dimensional space and variations in light almost as efficiently as the oriental fish polyculturist does in his ponds.

Traditional swiddening is characterized by the rudimentary nature of the energy involved. Fire, human muscles and the simplest of tools are all that are needed. Despite this, it apparently makes light demands on individual farmers while providing almost all their dietary requirements. Further, swiddening alters the ecosystem less than any other mode of farming of comparable production.

My description of swiddening is primarily based upon the observations and researches of Roy Rappaport who

observed its practice in the tropical rainforests of New Guinea by Tsembaga peoples (3).

At least 90% of the lands under a properly managed swiddening regime are allowed to lie fallow and return to secondary growth forest. Despite the fact that a tremendous amount of land is in a "wild" state, the entire Tsembaga territory supports a population density of 97 per square mile and their best lands support a density of approximately 200 persons per square mile; and they do this without degrading or despoiling the environment. (Costa Rica presently has between 95-100 persons per square mile, including San José.)

It is possible to imagine small cultivated plots intensely cropped and dotted throughout the forest. The forest itself contributes by providing its share of wild animals and hundreds of forest plants which are used in the manufacture of tools, house construction, dyes, clothing, drugs and medicines.

Since each garden is tended for at the most a few years, old gardens are frequently abandoned and each family is therefore almost always involved in the preparation and planting of new ones.

The first step in swiddening is the clearing of the underbrush and this task is carried out with machetes. This is hard work involving both sexes and takes up a considerable amount of energy. Several weeks are allowed to pass then the trees are cleared. They are felled then stripped of branches which are piled up on top of the slashed undergrowth. Trees with large trunks are left standing, while the remainder are dragged to the edge of the garden.

The felled trees are split and lashed together with vines to make a pig fence around the garden. The fences keep the domestic and wild pigs out of the garden when it is in use, and after it is abandoned the domestic pigs are often penned on the inside to root out the remaining crops.

After the fences are built the litter is burned as the weather becomes suitable. The burning is a crucial step as it eliminates the underbrush at the same time as it liberates minerals from the forest vegetation for the crops. Some of the lighter unburned logs are used for terracing to hold the soil while other logs mark the various plots.

The next stage in swiddening is the planting of the gardens. The Tsembaga people know and use some 264 varieties of edible plants from some 36 plant species. The starchy foods they commonly plant are several varieties each of taro *(Colocasia esculenta),* sweet potato *(Ipomoea batatas),* yams *(Dioscorea),* cassava *(Manihot dulcis)* and bananas *(Musa sapientum).* Several of these are fed to the pigs, and in fact each family has two gardens, one for their own consumption and another of comparable size for their pigs.

Other foods are beans (various), peas (various), maize *(Zea mays),* sugar cane *(Saccharum officinarum)* and a diversity of leafy greens. Hibiscus leaves *(Hibiscus maniot)* are an especially important source of protein. Cucumbers, pumpkins, watercress and breadfruit are also cultured as minor crops and the flowers of the New Guinea asparagus *(Setaria palmaefolia)* and pitpit *(Saccharum edule),* a relative of sugarcane, are relished. The fruit of one of the screw pines *(Marita)* is used as a sauce on the greens.

Although seeds are used, cuttings are the main source of planting stock and the gathering and planting of the cuttings is a very critical step. Holes are punched in the untilled ground and the cuttings or seeds are placed in the holes and covered.

The growth of the garden must represent an unbelievable sight when really well done. Here the fine art of ecological design stands out clearly. Rappoport's description illustrates applied ecology at its best in the tropics.

"In the garden, as in the forest, species are not segregated by rows or sections but are intricately intermingled, so that as they mature the garden becomes stratified and the plants make maximum use of surface area and of variations in vertical dimensions. For example, taro and sweet potato tubers mature just below the surface; the cassava root lies deeper and the yams are the deepest of all. A mat of sweet potato leaves covers the soil at ground level. The taro leaves project above this mat; the hibiscus, sugarcane and pitpit stand higher still and the fronds of the banana spread out above the rest. This intermingling does more than make the best use of a fixed volume. It also discourages plant-specific insect pests, it allows advantage to be taken of slight variations in garden habitats, it is protective of the thin tropical soils and it achieves high photosynthetic efficiency."

Weeding in the garden becomes a continual and essential task. Successive weedings are even known by specific names and they are carried out in order to uproot herbacious competitors of the crops. A fascinating fact is that tree seedlings are carefully protected and allowed to grow unimpeded, as it is recognized that soils' fertility can only be quickly restored through regenerating trees. Little trees are known to them as "duk mi" which means "mother of gardens". The presence of seedlings prevents grasses from invading and subsequently driving the ecosystem backwards to its simplest, unstable and most infertile state. Young trees capture the nutrients and reach down into the earth so that there will be fertility for future gardens.

What the swidden gardener is doing with an amazing foresight is going beyond caring for the species which feed him. The species of the forest are also cultivated and cared for as he knows that the future of his society depends upon these acts.

With the creation of a new garden every year or two the old garden is visited less frequently and it passes through the various stages on its way to becoming a forest again.

There is another interesting aspect of swiddening worth mentioning here. Professor Rappoport found that swid-

dening was efficient, despite the fact that it drew upon no elements of modern technology or outside sources of energy such as electricity or fossil fuels. The ratio of yields to input in the gardens is high, varying from 16:1 to 20:1. In light of the non-exploitive techniques involved this represents an efficient and productive form of earth stewardship. We have much to learn from the "primitive" gardeners in the humid tropical forests.

MODERN ANALOGS OF SWIDDENING

Modern man will never return to swiddening in the traditional way. Most people have lost the religious and social rationale for living such autonomous lives and they are far too irresistibly drawn to many of the trappings of the industrial societies to want to return to living without some of the tools and machines developed by "advanced" societies.

In a swiddening society everyone was a farmer and I do not think that farming as a universal occupation is either possible or desirable. Traditional swiddening could not be superimposed onto a contemporary tropical country without changes that would integrate it into the larger economic community. The swiddening farmer had no means of storing or transporting excess produce so cash inflow was unknown to him. His only cash crop might have been pigs, but in the case of the Tsembaga, they were slaughtered for religious festivals rather than for profit.

Nevertheless, if we are to become successful stewards of the humid tropical lowlands, we will have to draw inspiration for our efforts from traditional swiddening. In fact it is absolutely essential that the best methods of the past be emulated in designing the farms of the future. A relatively self-sufficient, modern system of swiddening could be developed which would also produce an excess of transportable foods for sale on the open markets and in my opinion this goal of creating productive and valuable farms could be accomplished without depleting the fertility of the vulnerable lowland soils.

Having been optimistic about the future, I must also introduce a strong note of caution at this juncture. Animals should definitely play an elemental role in the shaping of modern analogs, but the raising of cattle and other grazing animals should be avoided like the plague in the wet lowlands.

I do not think it was an accident that swiddening peoples in the old world raised pigs and avoided husbanding cattle. Cattle survive on grasses and in rainy tropical regions the coarse grasses can arrest the recovery of ecosystems and thereby stop or seriously hinder the regeneration of the soils (14). In fact grasses that are grazed can push ecological succession backwards, increasingly impoverishing the land. The rearing of pigs and fishes need not do any such thing and wisely managed they can play an important role in maintaining and improving the soil.

Alexander Skutch believes that one of the major reasons that civilizations of a high order flourished in the lowlands of the Americas for centuries before the European invasions was simply because the Mayans and others did not combine grazing with agriculture. I think there is genuine merit in Dr. Skutch's ideas. The raising of cattle in Costa Rica should be confined to the mountains and the drier western lands.

Swiddening, forestry and perennial food crops must provide the foundation of agriculture in the wet lowlands. It would be wise to superimpose upon these aquaculture and the rearing of pigs and fowl. These animals can be optimally raised in these regions and will add to the efficiency and profitability of the farms. Only very small pastures should be permitted so that draft animals and the family milk cow can have a place to graze.

A Biologically-Derived Farm for the Wet Tropics

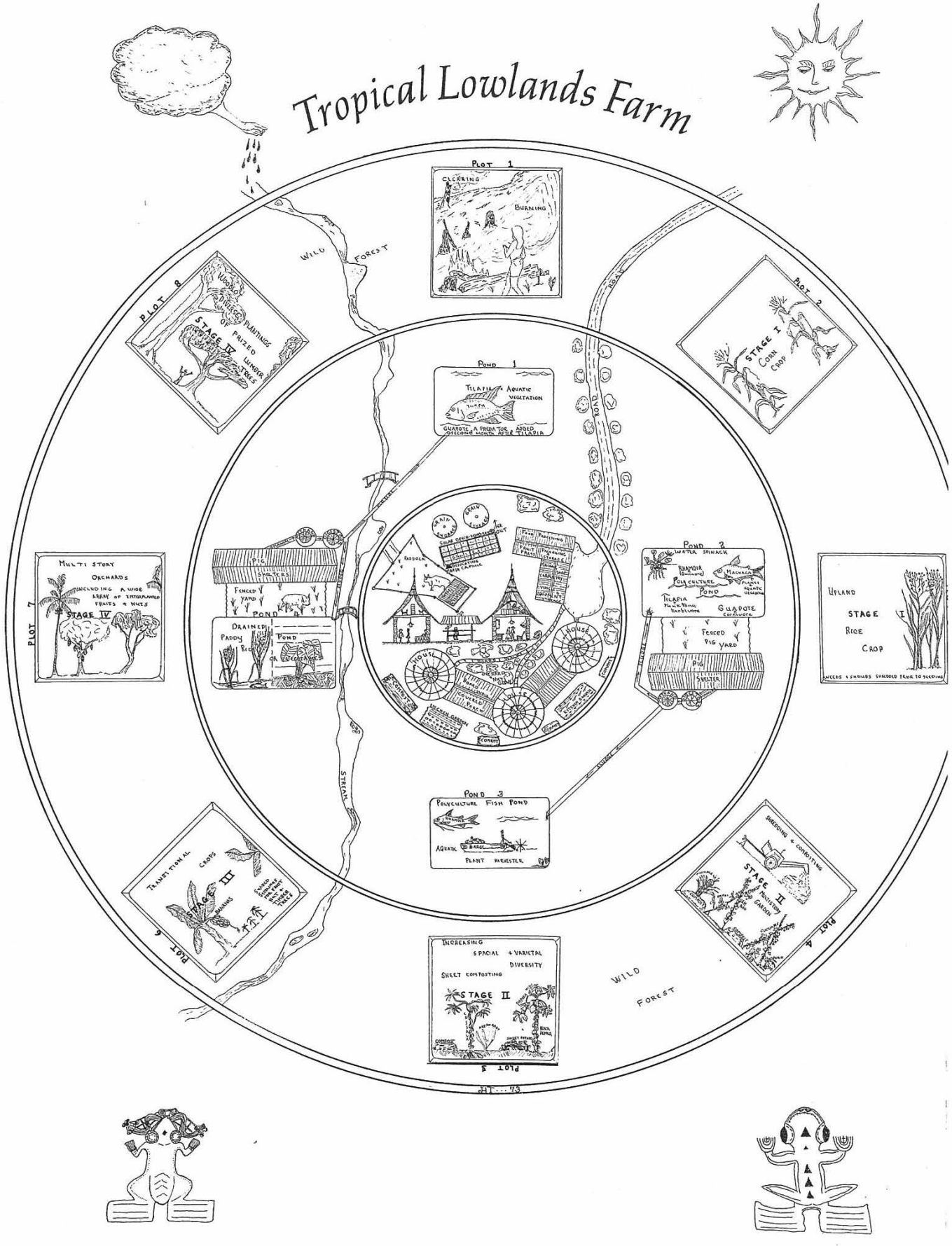
The farms of the future that I envisage would be unique, especially in the tropics of the Americas. They would be diverse and productive and would need a variety of machines to enable the farmer best to mirror the patterns of nature. At no time would the primary biological processes that characterize the ecosystems of each region be violated.

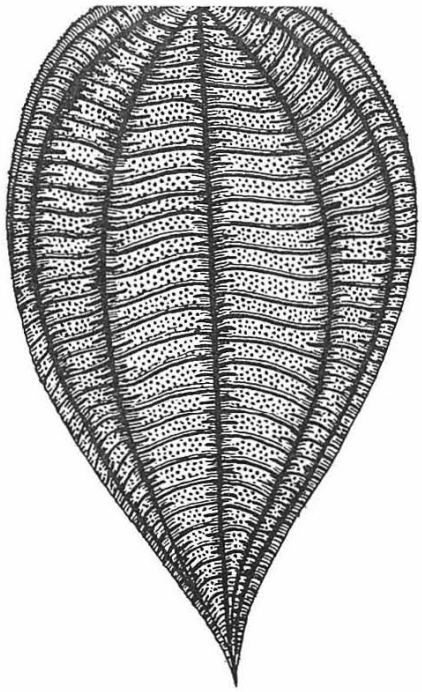
In order to combine ecological strategies with economic efficiency and productivity, each farm should perhaps be small, possibly limited to 50 acres or less. The reasons for the size limitation are straightforward: In a highly complex and productive agricultural system each element requires much more human attention and the orchestration of the farm as a whole necessitates a high degree of familiarity and understanding of each of the components. The size of the farm would best be limited to what the farmer can observe and supervise directly. It may be that this size limit would prove most viable economically, especially if there are cooperative schemes for processing and marketing of the foods on a regional basis. Smaller land units would also make possible a farming life for people with relatively little capital and land.

I want to describe a farm of the future with its roots in the past, which is only an idea and dream of what might be. My inspiration has been derived from many sources and from a number of different cultures. Perhaps not all of them can fit into Latin American cultures although most of them now exist there in one form or other. While some of the components are being tested on farms like the one at Granjas Tropicales, the various elements have yet to be woven together into a fully ecological farm that is reconstructive and profitable. The aquacultural components at this point are still at the exploratory stages.

Some of my suggestions might be off the mark, but hopefully they will stimulate new research and experimentation by many who intend to make the lowlands of Costa Rica their home.

Tropical Lowlands Farm





THE FARM

A model farm of the future should be carved out of the rainforest so that it may begin with the stored fertility of decades of biological activity. The land should not be entirely cleared, but have a series of small clearings of several acres each which would ring the farm. The small clearings, enclosed within the forest, will help ensure some ecological stability around each cultured plot and when the clearings are re-invaded, it will be with plants that are most likely to heal the degraded agricultural sites. These will be the seedlings of the forest itself.

Picture, if you will, a forested farm opened up over a period of years into a series of clearings around the perimeter of the farm. If you were to fly overhead you would see that each clearing is separated from the others by climax forest and since the clearing has taken place over a number of years, each opening would be different. Looking like wide spokes on a large wheel, each plot would be made up of different crops suited to the particular stage of maturity of the clearing. After a number of years the first or earliest opening would be hardly distinguishable from the surrounding forest being comprised of mature trees cultured from fruits, nuts, seeds, and high quality timber. The most recent clearings on the other hand might appear bare or charred from recent cutting and burning.

The houses and outbuildings might best be situated in the hub or center of the farm and outward from these polyculture fish ponds could be dug to create an inner ring which would appear like a sectioned moat from above. The pens and shelters for the pigs and fowl would be between the ponds and the forest, close to the ponds. Within the interior of the farm could be the buildings for food processing, areas for composting and household orchards, and small garden plots.

The symmetry of the model farm has a purpose. It should enable it to develop sequentially and logically from a forested area to a farm that is characterized by its affinities with the forest.

PREPARATION AND MAINTENANCE OF THE FARMING AND FORESTRY PLOTS

As was mentioned, the size of each agricultural clearing should be limited. This would insure that invasions of coarse weeds and grasses would be somewhat restricted and the life of the plot, if properly managed, could be extended for perhaps many years. Paul Harcombe (14) has recently pointed out how small openings in mature forests are filled by climax species by means of vegetative reproduction, release of suppressed saplings, or by the germination of buried seeds. This is significant for the tropical farmer as it means he would have to contend with woody plants in the cultured plots which is easier than controlling grasses and herbs. Also, he would have on hand saplings of wild trees to provide shade and support for his crops.

The first step in clearing would be to cut away undergrowth. This would have to be done with machetes. Then the largest trees would be removed for sale as timber and small trees would be burned within the clearing.
the intermediate and small trees would be burned within the clearing.

Burning, the next step, would not only help to release the nutrients and eliminate litter (which could also be accomplished by using a shrub chopper followed by mulching), but equally important the burning would destroy the roots and rhizomes of the original vegetation.

TRADITIONAL CROPS

Stage 1:

After clearing and burning the plots would be ready for planting of the stage 1 crops. Traditionally, these have been corn, which requires a lot of available fertility, and dry or upland rice. Plots in their first season might best be planted to these crops and excess production beyond the needs of the human community could be fed to pigs and poultry, or sold.

If the reinvasion of the plot was slow enough, it might be possible to plant the same crops a second time, especially if a mechanical chopper-shredder was used to shred the stalks and the woody plants and vines into a mulch. The mulch might slow down the rate of subsequent reinvasion and somewhat arrest the loss of nutrients from the soil. The type of chopper-shredder I am referring to is the large, gasoline-powered, transportable machine commonly used for disposing of shrubs, branches and small trees in northern U. S. communities. Its role in tomorrow's tropical farming might well be an important one. They could be drawn by oxen or by tractors.

Stage 2: Chopping, Composting and Raising Diverse Food Crops

The strategy through the second stage of the cleared plot would be to restore some of its fertility while growing a wide variety of crops suitable for sale and for consumption by the farm community and animals.

Although the method needs testing and experimentation, it is likely that some fertility could be restored through the chopping and shredding of the plants that have invaded the plots into windrows several feet deep. The windrows, in rows throughout the plot, would be innoculated with some soil and pig manure and allowed to compost. The compost when matured could be spread throughout the plot as a fertilizer.

The stage 2 gardens would be planted between the compost windrows. They would be multistory and diverse, like traditional swiddening gardens. Beans, peas, a variety of vine crops such as pumpkins, squashes, as well as root crops should be tried. Other less well known indigenous food crops could also be planted at this stage. Many of these could be valuable and saleable foods, while others would be solely for consumption by the people and animals on the farm.

Although it has not been demonstrated in the lowlands of the Americas, composting could well build up the soil's fertility. If this is found to be the case, then stage 2 crops might also include plants that produce for several years such as papaya, pepper and other spices. Those crops requiring support could be fastened to saplings that sprout up naturally and are permitted to grow to a particular height then topped and debranched.

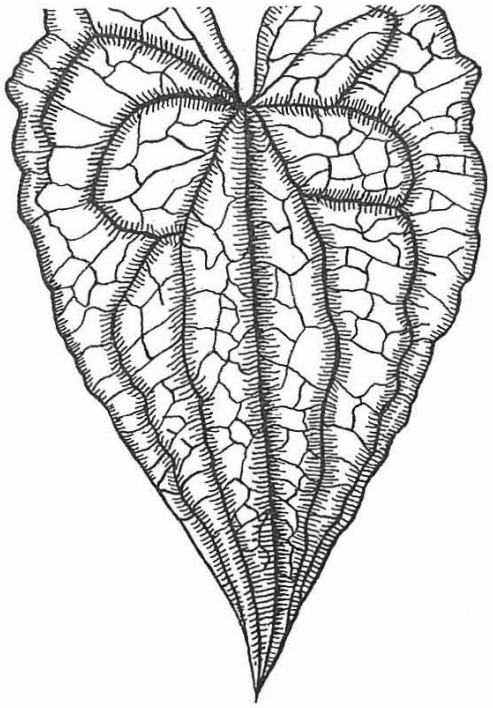
In order to slow the invasion of the site, cutting, shredding and sheet composting would need to be continued along the rows. Sheet composting is labor-saving but slightly less valuable compared with the traditional pile method, and consists of the shredded materials being allowed to decompose in shallow layers on the soil surface. The above techniques might allow the tropical farmer to continue the stage 2 process for five or six years, especially if, through composting, he was able to return to the soil the fertility he was removing with his crops.

Stage 3: Transitional Crops

The next stage is a transitional one in which bananas and plaintains are grown in the aging plots. Some seedlings would be allowed to grow up as well as to act as supplementary shade for the next stage. Shredding and sheet composting of plant materials should continue through this stage although less frequently. The bananas and plaintains have a wide variety of uses. The fruit would be for human and animal consumption and the leaves might be suitable as a food source for some of the cultured fishes.

Stage 4: Multistory Tree Crops

Stage 4 represents the final step of the farm plot to a mature and productive agricultural system. In the shade of the bananas and wild trees, a suitable habitat would



exist for seedlings of a great variety of potentially valuable tree crops.

Some plots could be planted to trees prized for their rare wood. Within a decade or two, with relatively little management after the first year or so, a timber crop of high value could be produced and sold, perhaps directly to brokers who deal in the finest tropical woods. Applied research into the growing of lumber crops of this type would reap rich dividends for any lowland region.

At the end of stage 4, when the trees are cut, the plot would be ready to return to stage 1 and the cycle would be repeated. Different cycles of varying duration could be tested on every farm.

The second approach to the stage 4 plots would be to plant a variety of fruit, seed and nut tree crops. These tropical orchards would begin to produce an income within a decade or less depending upon the crop. Each plot should have a number of different kinds of crops, varying in height and shade and root depth requirements. Many of the fruits could be processed locally or on the farm. Tropical juices, pressed and pasteurized, or sterilized would be very much in demand and could provide the basis for local agricultural industries. Many of the nuts and seeds command respectable prices for the farmer.

I do not have the experience or knowledge of tropical orchards to recommend the most suitable trees for the lowlands. Already cacao and rubber are important tree crops, but their prices are tied to fickle world markets. With many of the improved methods of processing foods, it would seem that the time is ripe to comb the world for suitable tree crops for the lowlands of the Americas. As

a biologist I have a bias towards indigenous or native crops, but there may be many trees that would add considerably to Costa Rican tree farming. An effort should be made in the immediate future to involve scientists, agriculturalists, farmers and the Costa Rican government in the establishment of a tree introduction center in the lowlands. The center would evaluate the suitability of promising trees for the culture of foods in Costa Rica. A few farmers are now experimenting on their own but a coordinated effort to test nursery stock and to make it available is urgently needed. Perennials, especially trees, are the plants best adapted to rainy tropical environments.

Stages 1-4 represent a man-made successional farm uniquely suited to the rain forests of Central America. At each stage the diversity and productivity climbs, and if properly conceived, the value of the crop should go up at each stage. Each swidden area has evolved into a highly cultivated, multistory orchard or grove of valued trees and the farm itself is protected by wild forest.

ANIMALS AND ENERGY: A BIOLOGICAL APPROACH

At the heart of the farm I am describing would be a complex for the culturing and raising of animals. The various components of the animal husbandry systems would be linked together. Each element would contribute significantly to the functioning of the whole, resulting in an advanced and profitable farm ecosystem. Pigs would be raised adjacent to the ponds and would be fed farm crops and aquatic plants. The pig wastes would provide the raw material for a methane generating plant capable of producing electricity and heat, the latter to be used for drying some of the crops. The methane plant wastes in turn would be cycled into the ponds to act as the major pond fertilizer. The enriched ponds would be productive of algae which represent the primary food input for polyculture fish farming. The raising of animals, especially pigs and fishes, could be achieved efficiently and optimally on a lowland farm. All the feeds would be grown on the farm, especially in the agricultural plots ringing the farm, and from the ponds themselves. Farms of this type could help meet the increasing demand for high quality pork and fish on a local and national basis. In fact the hot, tropical lowlands represent the very best environment for these activities.

PIGS AND FOWL

The potential for the raising of pigs and ducks in conjunction with the culturing of fishes is great and represents an extremely productive way of bringing together agricultural food chains in a mutually beneficial way. Recall the 4.4 hectare Chinese farm in Malaysia in which pig, fish and aquatic plants were raised together. Some 30,000 kg per year (approximately 66,000 lbs) of pig meat were produced with the primary feed being the aquatic water spinach (*Ipomoea repens)* which grew luxuriantly in the fish ponds fertilized by the pig manure. Besides the pigs, some 3,000 kg (6,600 lbs) of fish were cultured in the small ponds. The fish in turn fed primarily off the algae which proliferated in the enriched ponds.

Ducks could complement a system like this, their wastes being added to the ponds and to the methane generating plant. However, to my knowledge, there is little in the way of markets for ducks in Central America at this time.

In the model Costa Rican farm the pig sties and duck pens should be situated close to the ponds. This would facilitate feeding of aquatic plants to the animals and permit the animal wastes to be treated near their eventual outfall back into the ponds. The sties and pens should have sloped concrete floors so that the manure could be flushed directly into a methane fuel plant, and all feeding of the animals would best be carried out in the pens. Attached to the animal shelters would be yards for the animals to exercise, root about and wallow. The yards would drain directly into the ponds below.

The numbers of pigs and ducks raised on the farm at any given time could vary, depending in part upon market conditions, availability of foods and the need for fuel or electricity from the animal wastes. If a methane plant is not desired, then the number of animals could be reduced. However, a farm scale fuel and electricity plant developed in South Africa by John Fry required the wastes from an average pig population averaging 1000 individuals (15). His was an intensively managed 25 acre farm.

Because of the diverse nature of the farm, a variety of suitable pig feeds would be available including aquatic plants, a number of root crops grown in the successional gardens, fish guts and heads, and if rapid gain was important, some of the farm-grown corn and rice could be used. The catholic tastes of the pig make it an ideally-suited animal for this type of tropical farm.

METHANE AND THE PRODUCTION OF ENERGY

One hundred pigs produce about 400 lbs. wet weight of manure daily and this material could be dumped directly into the ponds as a fertilizer, or used as manure on the crops. On the other hand it might best be cycled through a farm scale displacement digester in which the manure is broken down and methane gas is produced as one of the end products. Methane gas can be used directly as a fuel for machinery on the farm, or it can be used to power a diesel engine which has been converted for methane use. John Fry used his 13 hp converted diesel for generating electricity. A water pump was also driven directly from the engine. The system produced some 8,000 cubic feet of gas daily. At today's U. S. prices this is equivalent to approximately $1,400 a year worth of fuel and the value of the effluent from the system could represent at least a comparable amount in

increased productivity in the fish ponds ringing the farm if they were properly managed. A detailed description of the system, including design information, has been given by Richard Merrill and John Fry in New Alchemy Institute Newsletter No. 3 (15). A methane system can be made to function reliably, as the Fry engine and digester combination ran continually with occasional stoppages for 6 years.

In tropical regions without a steady and reliable source of winds, the development of methane plants on a farm scale could help solve indigenous energy needs. The pig-methane-effluent-fish pond cycle takes advantage year round of the potential productivity of the tropics, with the effluent from the digesters becoming a critical factor in fish farming.

POLYCULTURE FISH PONDS

Much of the earlier discussion of pond culture on the hypothetical arid land farm in Guanacaste province applies equally along the humid and rainy Caribbean slope. Even the fish species cultured could be identical or closely related. The major difference between the small farm I am now describing and the Guanacaste model is that the effluent from the methane power plant would create more fertile and productive ponds in the humid lowlands. The ponds possibly could receive close to 1,000 gallons weekly of effluent originating from the pigs. If this energy could be trapped and used as efficiently as the Chinese in Malaysia manage in their ponds, then a major increase in high quality protein production could be achieved in the tropics of the Americas.

The fertilized ponds would be capable of producing prodigious amounts of algae and aquatic plants similar to the water spinach. The latter could be cultured in separate ponds or in combination with fishes, and would represent a substantial portion of the diet of the pigs. Fish culture would have to be designed around the food needs and ecological requirements of each species. A number of years of biological research will be needed to discover the must suitable fishes and to establish their stocking rates for polyculture in the Americas. Except for *Tilapia,* already introduced into Costa Rica, emphasis should be placed on native American species.

A possible roster of fishes to be tested are as follows:

Fish	*Food and Habits*
Tilapia spp.	phytoplankton feeders
Brycon spp. (Machaca)	leaves, fruits and terrestrial and aquatic plants
Rhamdia spp. (pimelodid catfishes)	omnivorous, nocturnal feeders especially on benthic or bottom animals
Cichlasoma spp. (guapote)	predator introduced to prevent overpopulation, especially of *Tilapia*
Joturus pichardi sp. (bobo)	habits not known, but highly prized fish, noted for the quality of its flesh

This is a hypothetical list and except for the *Tilapia* none of them to our knowledge have been cultured as a source of food, although all of them are sought by fishermen as food fish. The goal of New Alchemy fresh-water fish studies in Central America is to create analogs of oriental polyculture systems based upon fishes from the rich and diverse fauna native to the American tropics.

There still may remain the hurdle of marketing of fishes from the polyculture farms. Apart from local markets there is the distinct possibility that some of the species might be suitable for live transport to distant fish markets, while others could be sold freshly processed. In areas without inexpensive refrigeration, it would be necessary to process fishes locally for shelf storage. Some means for drying, smoking and "pickling" of fishes could be devised on a farm or local scale. Recently I had the pleasant experience of eating fish that were cooked and then preserved in olive oil, wine vinegar and garlic. The texture and taste was outstanding. A tropical equivalent might be to cook the fish briefly and then store them in a ceviche "sauce" which includes culanthro, also known as Chinese parsley or coriander. Raw fish in this "sauce" is excellent and much appreciated in Costa Rica and other parts of Central America. Unsaleable fish could be used as feed for the pigs.

PADDY RICE CULTURE

The ponds, drained after the fish are cropped, would be ideal for growing paddy rice. The rich bottom muck would help ensure a bountiful harvest and a rotational scheme could be worked out to take advantage of ponds which occasionally lie fallow. Rice farming would diversify the farm's subsistence base and, if carried out on any scale, it could provide an additional income source.

Tragically, modern rice culture using the high yield strains of rice usually requires a variety of biocides including insecticides to nurse the crop through to its final stages. These poisons would be extremely harmful to the pond ecosystem, so if rice could not be grown organically in the region, then it should not be introduced as a crop on the model farm.

THE TECHNOLOGICAL BASES FOR MODERN TROPICAL FARMS

Space limitations prevent a detailed discussion of the kinds of technology that would be most helpful on the kinds of farms described in this article. Ecologically-derived farms would have unique requirements, which could not be completely met by established agricultural equipment manufacturers. In the long run, this vacuum might turn out to be a boon to tropical societies, as it might induce indigenous inventions or stimulate efforts where possible to substitute biological solutions for the strictly technological ones of orthodox agriculture. For example, there are two basic ways to control serious damage to crops from insect pests. One approach is to spray a monocrop with a powerful insecticide, whereas

the alternative is to use ecological strategies against pests which include limiting plot size and proximity and interplanting several crops in the same plot. The latter strategy represents a predominance of biological thinking, which, over the long term, could well prove most suitable against the vicissitudes of hot tropical environments.

Even on an ecologically-inspired farm a variety of machines would be needed as toil-saving devices and for increasing the efficiency of the farm and for processing of the foods for market. Oxen and horses should remain as beasts of burden on the farms of the future, as they require little in the way of capital and perform some tasks more efficiently than tractors or other vehicles, especially during the rainy season. They also do not require increasingly expensive gasoline and oil.

INDIGENOUS TECHNOLOGIES

Local economies and individual tropical farmers could be aided and strengthened by indigenous manufacturing of a variety of equipment and tools. Savonius rotors for pumping water, windmills for pumping or generating electricity (see "Energy" articles in this issue), simple pumps, many of the methane plant components, buildings and a variety of other useful devices could be produced on the farm or in local blacksmith shops. Some food processing equipment could also be built on the spot such as solar driers, fruit presses, solar and wind-powered ice making or freezer units.

As local engineer-crafters begin to develop proficiency, a tendency could evolve to turn to indigenous materials. One example comes immediately to mind, namely fabricating the piping for the water and aquaculture systems from large varieties of bamboo. As ecological farming practices are worked out, there will be a need for new kinds of planters, cultivators and harvesters. If these could be built locally, the diversity and economy of the regions affected would also be strengthened. The stability and social richness would be far greater than in farming areas based on single cash-crop farms or plantations.

IMPORTED TECHNOLOGIES

Some imported technology will be required to make the farms productive, efficient and a pleasure to work. Power saws and chopper-shredders will be needed for clearing and composting; and tractors might help with the turning of the compost, the digging of ponds and the moving of materials. Pasteurizing or sterilizing equipment and some power tools and vehicles for transporting food to markets will need to be brought in from outside.

The success of these farms and the communities associated with them will depend, to a large degree, on there being a healthy balance between the local manufacture of machinery, equipment and structures and the expensive imported aids for farming and living in the tropics. Farms like those I have described will need minimal outside equipment and machinery, but that which is required will play an important role. Unfortunately, we still know very little about the most appropriate technologies for biologically-inspired tropical farms.

CAN IT ALL HAPPEN?

As I reflect upon the future, especially as it pertains to the tropics of Latin America, I am overwhelmed by how much has to be accomplished to reverse the course of land exploitation before the task becomes too difficult and whole regions have to be abandoned. Alternative farms will have to exist by the turn of the century, and they will have to appeal widely to tropical farmers—farms, like beacons upon a wasted sea.

But I am not optimistic about the future. The magnitude of the present dilemma is not clearly recognized, nor is there much chance of finding support to create model farms that represent, in microcosm, the most valuable of nature's processes. Frightening too is the tendency for agencies, organizations and governments to tackle problems on a piecemeal basis, and on too large a scale for individual farmers to relate to. I have observed that people react to new ideas or things very differently, and I suspect the reaction depends on whether the new idea or thing can be actualized by them within their present resources. Small farmers at agricultural fairs are no doubt impressed with the sight of computer consoles that can operate myriads of machines on a mechanized farm, but their reaction is quite different to people who see the small backyard fish farms at our Cape Cod center. These inexpensive little aquafarms are as strange as the consoles, but the immediate reaction is not one of awe, but is more likely to be "I'd like to try that". Anyone with a 25'x25' plot of land can have a small fish farm, but the remote and esoteric console and its array of machines exist in the realm of the "expert" and the large corporate farm. The viewer sees it as an occupant of a world other than his own.

Another variable that dampens my optimism is the tremendous amount of energy, scientific study and plain hard work that will be needed to construct viable alternatives. Our experience at the New Alchemy-East center has shown us how little is known and how much work is required. Not to be overlooked is the vital question of communicating knowledge and perspectives outward so the best approaches and strategies can become widely emulated. People everywhere must become experimenters with the world around them. To give them the necessary confidence is one of the most important but little discussed or understood tasks ahead.

A beginning has to be made, and soon, as the spectre of hardships before us is too great. Armed with what is already known, functional demonstration farms like the ones described should be researched and developed. Financial support will have to be sought as good experimentation will have to include the luxury of testing hunches and ideas that may well fail as well as those that

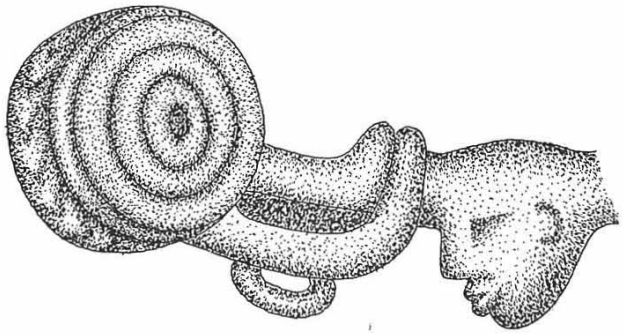
succeed. The search for modern tropical farming methods will not be a direct and straightforward path.

Local or regional governments could play an elemental role in the restoration, either by establishing models themselves or by underwriting some experimentation by farmers. Perhaps they could do both. Another valuable contribution would be the establishment of regional plant introduction groves, nurseries, hatcheries for fish, and pig breeding stations so that the best quality stock would be available inexpensively to farmers adopting ecological methods. Small international research organizations like New Alchemy should play a role too because of their ties with practices in other parts of the world. In specific terms we would like to continue and to expand the studies of Bill McLarney in searching for native fish species suitable for culturing. If the wherewithal can be found, we would also like to collaborate with local people in the establishment of a reconstructive farm in Costa Rica.

Another key step to bring about constructive change might be to establish throughout Costa Rica an independent organization of ecological farmers with the purpose of sharing ideas, stock, research notes and the spreading of bio-social ideas into the larger agricultural community. Cooperative and educational ventures should be emphasized. It should be run by full-time farmers desirous of making their country balanced and productive.

Costa Rica is a beautiful and potentially productive land. If a few people with vision and foresight were to embark upon some of the proposals that have been presented here, then one day a dynamic might be born that would fulfill its promise as a country blessed with restored and productive landscapes and a free and self-reliant people.

—John Todd



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   See also Ramon Margalef, 1969. *"Perspectives in Ecological Theory."* The University of Chicago Press, 111 pp., and

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   See also F. H. Bormann and G. E. Likens, 1967. Science, Vol. 155, 424.
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8. Daniel Janzen, 1970. *"Herbivores and the Number of Tree Species in Tropical Forests."* The American Naturalist, Vol. 104(940), 501-528.
9. José Maria Arias Rodriguez, 1972. *"Fruticultura Tropical."* Lehmann, San José, Costa Rica, 243 pp.
10. Michael Evanari, Leslie Shanan and Naphtali Tadmor, 1971. *"The Negev: The Challenge of a Desert."* Harvard University Press, 345 pp.
11. The reference to the Russian work comes from a brief abstract sent to me by Marsha Zilles. The abstract came from an Architectural Design publication with no reference to the original paper. We have yet to locate the original source or a translation of it.
12. John Bardach, J. Ryther and W. O. McLarney, 1972. *"Aquaculture."* Wiley Interscience, 868 pp.
13. K. F. Vaas, 1963. *"Fish Culture in Freshwater and Brackish Ponds."* Chapter In: J. D. Ovington, Ed., The Better Use of the World's Fauna for Food. Symposium of the Institute of Biology No. 11, 175 pp.
14. Paul Harcombe, 1973. *"Plant Succession and Ecosystem Recovery."* Unpublished manuscript.
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A Preliminary Bibliography:
The Use of Land and Waters in the American Tropics

This bibliography is a very tentative beginning. We intend to make it more complete. Please send us annotated references of books and papers that you have found significant. Technological references are important too, as we hope to publish a bibliography of "Technologies for the Tropics" in a future issue.

1. Allen, Paul H. 1956. *"The Rain Forests of Golfo Dulce."* The University of Florida Press.

   It's a helpful guide for the recognition of trees, especially of the humid lowlands.

2. Arias-R., José Maria. 1972. *"Fruticultura Tropical."* Lehmann, San José, Costa Rica, 243 pp.

   Only organic agriculture book for the tropics that we know of. In Spanish.

3. Bardach, J., J. Ryther and W. O. McLarney. 1972. *"Aquaculture."* Wiley Interscience, 868 pp.

   This is the definitive text on the farming of aquatic plants and animals. Includes tropical species.

4. Bates, H. W. 1848. *"A Naturalist on the Rivers Amazon."* Recently reprinted in a paperback edition.

   He discovered 8,000 new species of plants and animals and has something to tell us about the tropics. There is drama here too.

5. Chandler, W. H. 1950. *"Evergreen Orchards."* Lea & Febiger, Philadelphia.

   A classic text.

6. Evanari, M., L. Shanan and N. Tadmor. 1971. *"The Negev: The Challenge of a Desert."* Harvard University Press, 345 pp.

   This is one of the most stimulating books on land restoration anywhere. Practical, scientific and touched by mysticism. Similar orientation to New Alchemists.

7. Gifford, J. 1934. *"Diversified Tree Farming for Tropical Homesteads."*

   We don't even have the publisher's name for this book, but it sounds intriguing. If anybody locates a copy that's for sale, we would like to purchase it.

8. Hickling, C. F. 1971. *"Fish Culture."* Faber and Faber, London.

   One of the best books on raising fishes. A lot of material is devoted to the tropics.

9. Holdridge, L. R. 1971. *"Forest Environments in Tropical Life Zones: A Pilot Study."* Pergamon Press.

   An excellent guide to forest ecology in the tropics by a man with many years of experience.

10. Masefield, G. B., M. Wallis, S. G. Harrison and B. E. Nicholson. 1969. *"The Oxford Book of Food Plants."* Oxford University Press, 206 pp.

    A cursory but still valuable introduction to crops grown in the tropics with excellent illustrations, the latter worth the price of the book.

11. Mortenson, E. and E. T. Bullard. 1970. *"Handbook of Tropical and Sub-Tropical Horticulture."* U. S. Agency for International Development, Washington, 186 pp. Available from Superintendent of Documents, U. S. Printing Office for $2.25.

    This is an extremely valuable guide to vegetable and fruit growing in the tropics. The major drawback is that the authors would have us poison the planet half to death. Their roster of chemicals in the insect control section is downright unnerving.

12. Ochse, J. J., M. J. Soule, M. Dijknen and C. Wehlburg. 1961. *"Tropical and Subtropical Fruits."* MacMillan Co.

13. Odum, H. T. 1971. *"Environment Power and Society."* Wiley-Interscience, 331 pp. May also be a paperback.

    Deals with many of the processes which lie at the foundation of an ecological ethic. Intended here as the ecological equivalent to the "I Ching", especially for approaches to problem solving. The system's jargon will bore some people.

14. Poponoe, W. 1920. *"Manual of Tropical and Subtropical Fruits."* MacMillan Co.

    We haven't seen it but old hands tell us it's very valuable.

15. Purseglove, J. W. 1968. *"Tropical Crops."*
    Volume 1 - Dicotyledons 1
    Volume 2 - Dicotyledons 2
    Longmans, Green and Company Ltd.

    These big expensive volumes are indispensible if you plan to grow tree crops in the tropics. There are good descriptions of climate preferences and culture methods. Very highly recommended.

16. Skutch, Alexander. 1971. *"A Naturalist in Costa Rica."* University of Florida Press.

    His natural history provides plenty of insights into biological farming and land restoration in the tropics. His writing style is unique.

17. Smith, J. Russell. 1953. *"Tree Crops: A Permanent Agriculture."* Devin-Adair Company, 408 pp. Recently reprinted.

    This book really describes the power of trees, especially over human societies and is capable of providing fodder for dreams of restored landscapes, fertile soils and happy peoples. Some discussion of the tropics.

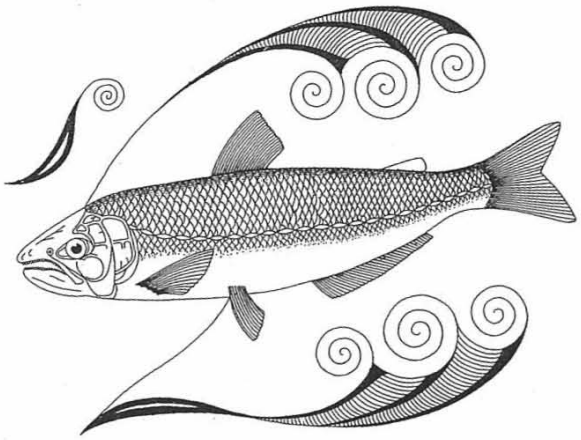
18. Sornay, P. 1916. *"Green Manures and Manuring in the Tropics."* John Bale Sons and Danielsson Ltd., London
    Richard Merrill told us about this book. It sounds as though it could be an important volume.

19. Standley, Paul C. 1937. *"Flora of Costa Rica."* (Two parts). Field Museum of Natural History, Vol. XVIII, Chicago.

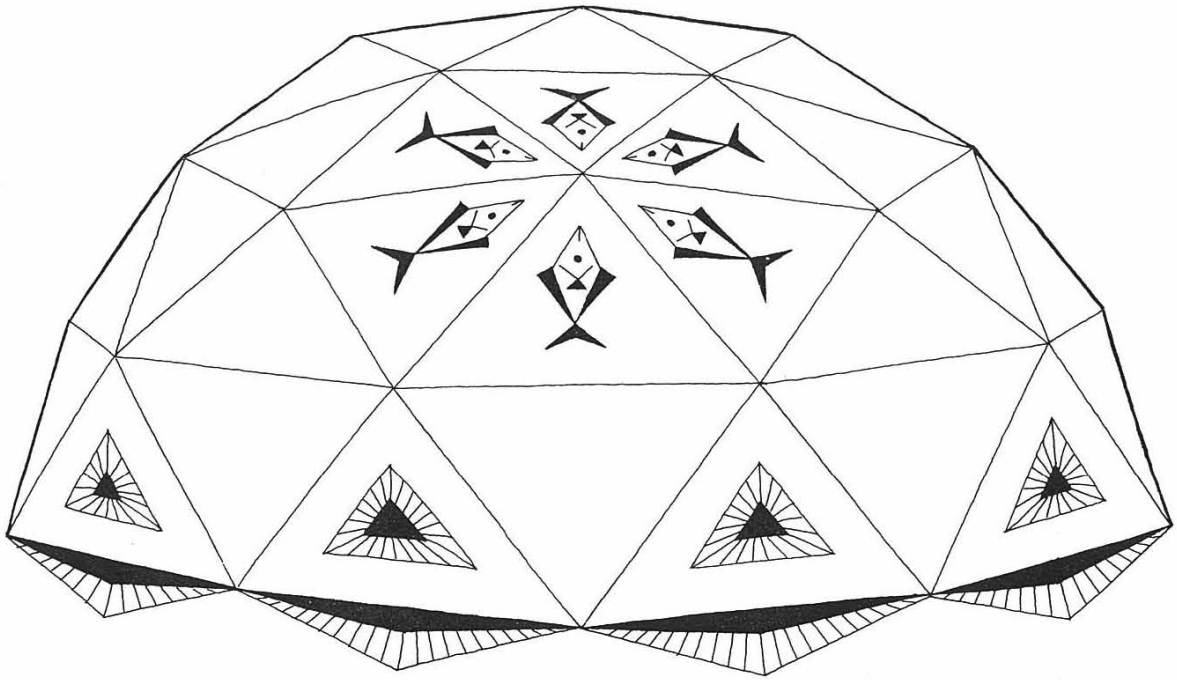
    It's what it says it is.

20. Villaluz, Domiciano. 1953. *"Fish Farming in the Philippines."* Bookman, Inc., Manila

    We haven't seen this, but it is supposed to be valuable.



Aquaculture



Granted, none of us managed to get our picture on the cover of the Rolling Stone, but some of you may have noticed that on the cover of the second issue of Lifestyle there appeared a rather angular figure with a shock of dark hair. The figure, outlined against the side of a dome, and leaning over a pool, was that of Bill McLarney. Although Lifestyle explained that he was engaged in feeding the fish, he was actually taking a turbidity reading of the water with a secchi disc. Dr. McLarney at work is unique. He can usually be found by following the freshest trail of beer cans or by tracking the sound of a sustained irritated mutter.

He has established some unique records since the days that he was spelling champion of Cattaraugus county for two years running. He has been photographed netting a butterfly while falling backwards down a cliff. He has been trapped, suspended by his armpits on the rim of an eight foot fish tank when the saw horse that he was standing on overbalanced, and he steadfastly refused to abandon the fish he had just captured.

His field work in Costa Rica, the description of which follows, was wonderfully entertaining to watch. Clad in sun hat, fisherman's vest, shorts, and running shoes he pursued his quarry through the water with Chaplinesque élan. In both his science and his writing his standards of excellence are irreproachable but being around the work actually in process is to be part of an on-going comedy.

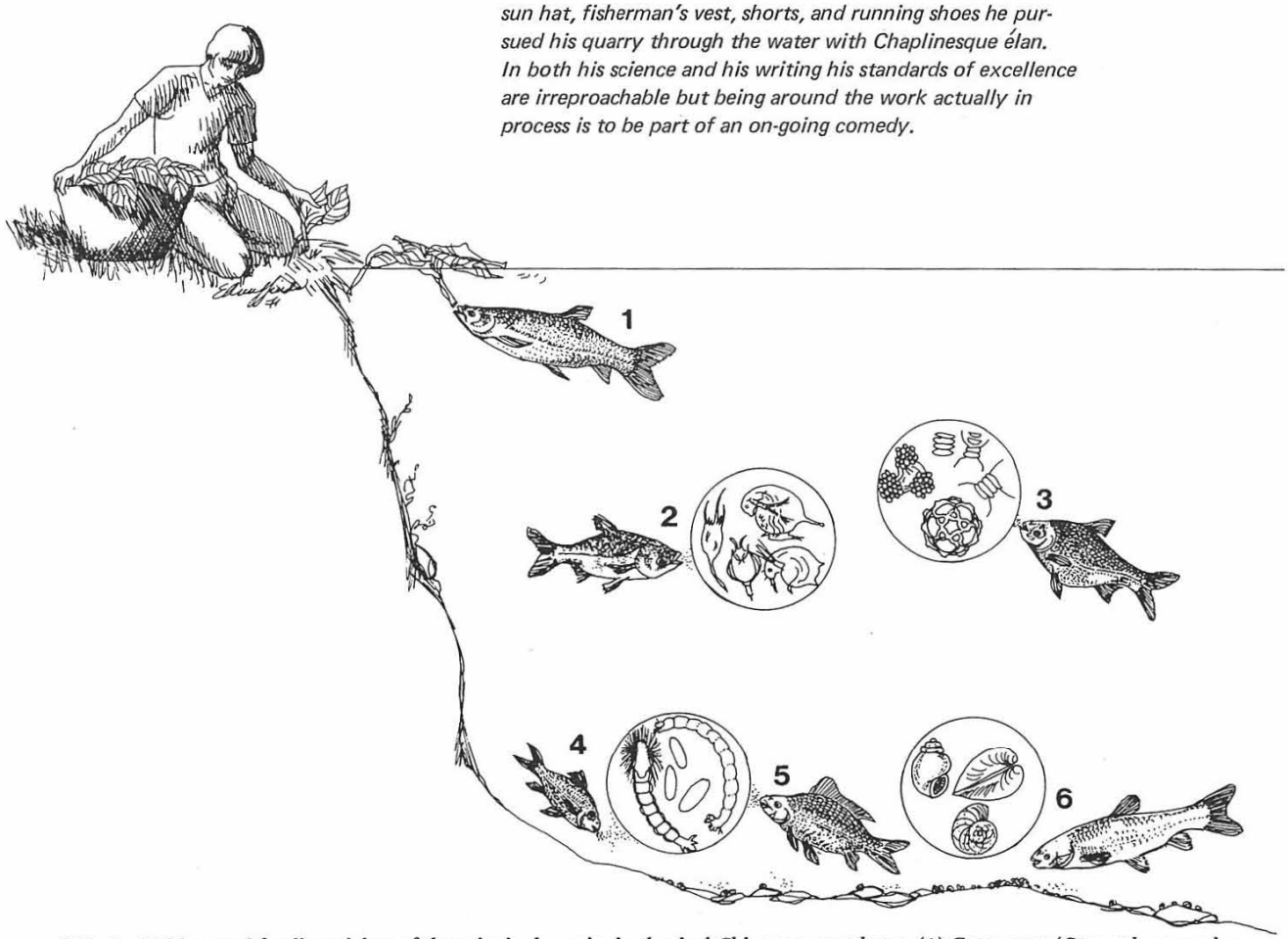


FIG. 1 Habitat and feeding niches of the principal species in classical Chinese carp culture. (1) Grass carp (*Ctenopharyngodon idellus*) feeding on vegetable tops. (2) Big head (*Aristichtys nobilis*) feeding on zooplankton in midwater. (3) Silver carp (*Hypophthalmichtys molitrix*) feeding on phytoplankton in midwater. (4) Mud carp (*Cirrhinus molitorella*) feeding on benthic animals and detritus, including grass carp feces. (5) Common carp (*Cyprinus carpio*) feeding on benthic animals and detritus, including grass carp feces. (6) Black carp (*Mylopharyngodon piceus*) feeding on mollusks.

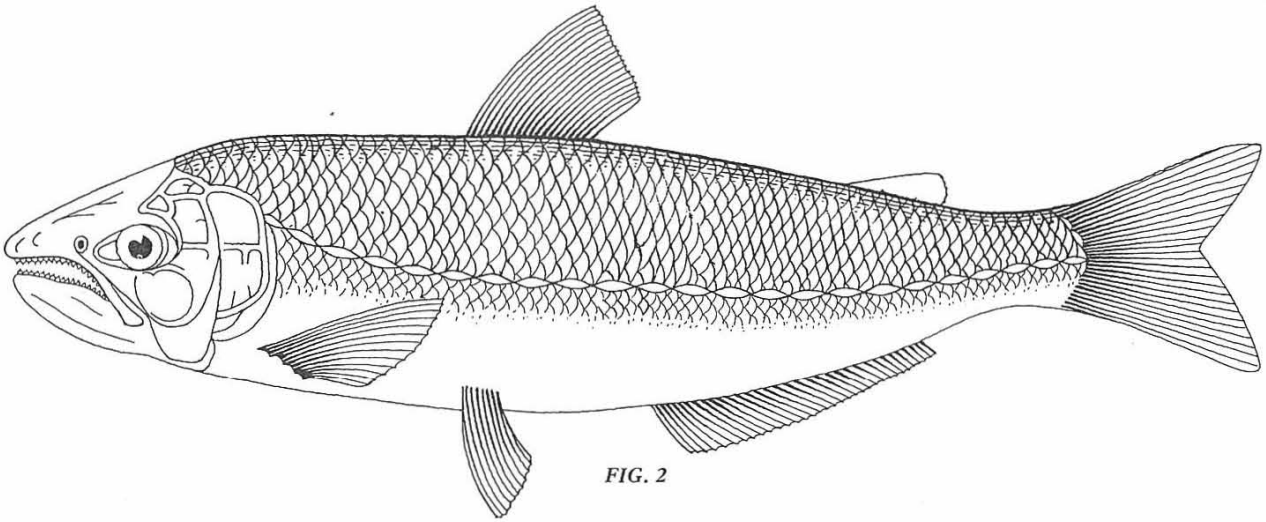


FIG. 2

Introductory Remarks

The chief nutritional problem of the peoples of Latin America is a shortage of protein. While the problem is not nearly as severe in Costa Rica as in many other countries by U. S. standards, high-protein foods are scarce and expensive. One protein source which is always mentioned when this problem is discussed is fish. The fresh waters of Latin America support a great variety of fish, many of which are utilized as food to some extent, but the rivers could never begin to support a fishery of a size commensurate with the human population.

Aquaculture has often been suggested as a means of providing protein, but few projects have been undertaken. The little that has been done has neither been aimed at enabling individuals or communities to grow their own fish, nor at providing protein for those who need it. Rather, existing installations and most aquaculture research in Latin America have dealt with raising high-priced fish for restaurant trade or for export to the United States.

It is informative to contrast the situation there with that in tropical southeast Asia, where though population density is often higher, protein deficiency is less prevalent, and cultured fish is an important component of the diet. The Asian peoples, particularly the Chinese, have over thousands of years developed methods of producing high yields of fish with low inputs of money and technology. Their success may be attributed to their recognition of two facts:

1. "A body of water is a three-dimensional growing space. To treat it like a field, by planting only one kind of crop, is likely to result in wasting the majority of that space."

2. "Any fertile pond will produce a number of different fish food organisms. However, most fish are not omnivorous, but rather selective in their diet. Thus stocking single species wastes not only space but food." (Bardach, Ryther and McLarney, 1972)

Chinese fish culturists take advantage of these characteristics of the pond environment through polyculture by stocking several types of fish, rather than just one, as is prevalent in the West (Figure 1 is a graphic illustration of polyculture in practice.) They further enhance the system by integrating the cultivation of the pond with terrestrial farming through the use of vegetable wastes as fish food and manures as pond fertilizers. Wastes and enriched water from the pond can in turn be applied to the land.

While it is the Chinese who have pioneered pond polyculture, some of the highest yields are achieved in the tropical portions of Asia, where a year-round growing season, coupled with the Chinese techniques, permits production levels which American aquaculturists, for all their technological and economic advantages, have not been able to duplicate in standing water.

There is a tremendous diversity of fresh water fishes in Latin America which could serve as the basis for an analog of the Chinese system, but this has never been tried. We have prepared a research proposal for the development of a pond polyculture system based on native Costa Rican fishes. Pending funding of this project (ca. $33,000 annually is needed), we have begun to investigate the ecology of some of the fishes which might find use in such a system. The information collected on these little-studied fishes should prove invaluable in our aquaculture efforts. The report which follows is the first published result of these investigations.

Studies of the Ecology of the Characid Fish Brycon guatemalensis in the Rio Tirimbina, Heredia Province, Costa Rica

with Special Reference to its Suitability for Culture as a Food Fish

INTRODUCTION

"Despite the severe protein problems of the peoples of Latin America, fish culture is almost unknown in that part of the world. Most of the attempts that have been made have involved exotic fishes. However, (Latin America) supports a diverse fish fauna among which are certainly some species suitable for culture" (Bardach, Ryther and McLarney, 1972). A few efforts have been made to evaluate native species for suitability for culture (de Menezes, 1966; Lin, 1963) but only a small fraction of the available species have been considered.

Development of culture systems for native fishes of Latin America is further retarded by the paucity of information on the ecology of these fishes. From the little that is known, it would seem feasible to develop Latin American analogs of traditional Asian pond polyculture systems. Among the major components of such systems would certainly be some of the 1,350 or so known species of the family Characidae. The Characidae, according to Weitzman (1962) *"present one of the most extreme cases of evolutionary radiation and adaptation among living vertebrates"* and *"one can easily envision.... a community comprising plankton feeders, benthos feeders, herbivores, and predators - all native South American characins" (Bardach, Ryther and McLarney, 1972).*

This report is the result of a preliminary investigation of the ecology of one potential component of such a community, *Brycon guatemalensis,* (Figure 2) known in Costa Rica as the machaca (not to be confused with the famous insect of the same name). Emphasis has been placed on those aspects of the ecology which are of particular interest to fish culturists.

B. guatemalensis is one representative of a large, but little studied genus of primitive characins. A literature search going back to 1925 disclosed only 26 publications dealing with fishes of the genus *Brycon.* In all, 46 species ranging from Guatemala to Argentina are mentioned, but almost all of the studies are purely taxonomic in character, containing little or nothing of use to fish culturists.

DESCRIPTION OF THE STUDY SITE

The observations reported here were made in the Rio Tirimbina, located at an elevation of 200 m (660 feet) in Heredia Province, Costa Rica. The study area extended from the village of Tirimbina, downstream for a distance of about 3 kilometers (2 miles). At this point the Tirimbina is a riffle-pool type of stream with a moderately high gradient and a gravelly-to-rocky bottom. Water depth during the dry season (February-March) when the studies were made, varies from as little as 50 mm (2 inches) at mid-stream in some riffles, to about 2 m (6.6 feet) in the deepest pools. From the distribution of debris along the banks and in overhanging branches, it appears that during the rainy season water levels at least 1.5 m (5 feet) above this are sometimes reached. In addition to rocks, fallen trees, log jams, and some deeply undercut banks provide cover for fish. During the study period the water was almost always clear, with visibility restricted only at the bottom of the deepest pools. Such turbidity as was observed was due primarily to the presence of people in the river, rather than to meteorological events. The clarity of the water is undoubtedly partially due to the largely forested state of the watershed; about 90% of the banks in and immediately above the study area are forested, with the remainder in pasture. Water temperature was stable at 22-25°C (72-77°F) during the study period. No water chemistry was done, but the Tirimbina, like other streams in the area, is known to be soft, acid and low in mineral content.

Fish species sharing the study area with *B. guatemalensis* are listed in Table 1. Other species may have been present but escaped detection, for example *Synbranchus marmoratus* and *Rivulus isthmensis,* both of which are known from the vicinity, but have secretive habits. Still other species may enter the Tirimbina from the Rio Sarapiqui, which has a much larger fish fauna, including a number of representatives of normally marine groups. Other aquatic animals present included snakes, turtles, shrimp, and a variety of insect larvae, none of which appeared to be especially abundant.

AGE AND GROWTH

It is not possible to determine the age of tropical fishes by examination of scales or sections of bone, as is done with temperate zone fishes, since growth in the tropics is year-round and no annuli are formed. If, however, there is a short, well-defined spawning season it may be possible to determine year classes by plotting length-frequency data. The lengths of fish within each

year class will cluster around the mean, so that the number of year-classes present is indicated by the number of peaks and valleys on the graph. With this in mind, a total of 130 *B. guatemalensis* were captured by seining during the period of February 23-March 11. Total length of each fish was measured and data plotted (Figure 3).

No statistical analysis was attempted on the length-frequency data, but it is doubtful if any case could be made for the presence of distinct year-classes. On the other hand, it seems extremely unlikely that fish spawned at the same time, living in the same environment, would exhibit such extreme diversity in size. It appears probable that, while spawning in *B. guatemalensis* is seasonal, the season is the rainy season, which on the Atlantic slope of Costa Rica lasts for eight months. (There are no recorded observations of *Brycon* spp. spawning, but rainy season spawning is typical of many tropical fishes. Dr. William Bussing of the University of Costa Rica has collected characin eggs, probably of *B. guatemalensis,* in the Rio Puerto Viejo, not far from the Tirimbina, at various times throughout the rainy season.) Thus, *B. guatemalensis* of the same "year-class" could differ in age by as much as eight months, which would account for the great discrepancy in size.

The only published study of age and growth in *Brycon* is that of de Gil (1949) who found that *B. orbignyanus* of Argentina and Uruguay grew slowly after the first year. One year old specimens were 75-125 mm (3.5 inches) long (standard length), but four year olds were only about 200 mm (8 inches) long. The oldest fish examined by de Gil was 17 years old and measured 604 mm (about

TABLE 1

List of Fishes Identified from the Rio Tirimbina
Near the Village of Tirimbina
February - March, 1973

Species	Family	Food	Habitat	Abundance
Astyanax fasciatus	Characidae	Mostly plant material of terrestrial origin; some insects	Pools	Very Abundant
Brycon guatemalensis	Characidae	Mostly plant material of terrestrial origin; insect larvae in young specimens. See text for details	Pools, chiefly toward the tail; undercut banks	Abundant
Phallichthys amates	Poeciliidae	Probably algae	Backwaters and shallows near shore	Abundant
Priapichthys annectens	Poeciliidae	Probably algae	In all but swift flowing water	Very Abundant
Rhamdia underwoodi	Pimelodidae	Probably carnivorous	(Only one specimen taken from pool)	Rare
Cichlasoma alfari	Cichlidae	Detritus (?)	Pools and backwaters	Common
Cichlasoma centrarchus	Cichlidae	Detritus (?); seen picking over surface of dead leaves	Pools	Common
Cichlasoma dovii	Cichlidae	Carnivorous on a wide range of organisms	In the Tirimbina, apparently ranges widely with no home territory. In Guanacaste, usually found in pools near cover, especially logs.	Occasional
Cichlasoma spilotum	Cichlidae	----------	Moderately fast water; almost always seen within 100 mm (4 inches) of a log or rock	Common
Cichlasoma tuba	Cichlidae	Mainly algae, but may be caught using earthworms as bait	Shallow, flat-topped water, usually near shore	Common

24 inches). It should be mentioned, however, that *B. orbignyanus* lives in a temperate climate, thus growth is arrested for part of the year. According to Sterba (1963) *B. falcatus* of the Guianas *"grows very rapidly when well fed".*

Figure 3 indicates a reduced number of fish above 90 mm (3.5 inches), but this may be due not to the actual numbers of such fish in the population so much as to greater difficulty of capturing the larger specimens. The largest fish taken in the seine measured 155 mm (6.5 inches), but individuals as long as 400 mm (16 inches) weighing up to 1.25 kg (2.5 lbs.) were taken from the Tirimbina. In the nearby, larger, Rio Bijagual diving disclosed *B. guatemalensis* which were estimated to weigh as much as 2 kg (4.4 lbs.)

Many characins less than 30 mm (about 1 inch) long were also captured, but these were not recorded, due to the impossibility of consistently distinguishing between *B. guatemalensis* and *Astyanax fasciatus* in that size range.

BREEDING

Almost nothing was learned of the spawning habits of *B. guatemalensis.* Only four of the specimens opened to examine the gut contents displayed sufficient gonadal development to permit the determination of sex. As mentioned above, there is reason to believe that *B. guatemalensis* spawns throughout the rainy season. This is slightly at variance with the suggestion by Lowe (1964) that *B. falcatus* spawned chiefly at the start of the rainy season. Von Ihering (1930) suggested that Brycon in Brazil spawned in mid-river and that the eggs floated ashore to develop amidst submerged plants.

Our meager knowledge of natural breeding notwithstanding, it seems unlikely that reproducing *B. guatemalensis* in captivity will prove a major difficulty in their culture. The technique of inducing breeding by pituitary injection, invented in Brazil (Das and Khan, 1962) has proved effective on a wide variety of characins in that country and should prove readily adaptable to *B. guatemalensis* in Costa Rica: Or, it might prove possible to duplicate the results of Lake (1967), who was able to spawn a number of Australian fishes which are characteristically rainy season spawners, by manipulating the water level.

FEEDING HABITS

The gut contents of 40 *B. guatemalensis,* ranging from 61 to 400 mm (2.3 to 16 inches) in total length were examined. This work was done under field conditions and is necessarily crude. Quantitative assessments were not made; only the presence or absence of each food type was noted. Table 2 lists the number and percentage of fish in two size categories which had consumed several types of food. As a microscope was not available, insects were identified only to order.

Of particular interest to fish culturists is the relative importance of animal and plant foods. Of the 18 larger fish, 17 - or 94.4% had eaten vegetable matter. (The one exception was a specimen with a completely empty digestive tract.) Only six (33.3%) had consumed any animal food. The preference for plant material would be even more striking if quantitative data were available; most specimens contained large masses of leaves and/or fruit pulp, while the animal constituent of the diet was usually represented only by a few small individual organisms. The smaller fish were more omnivorous; 20 of 22 (90.9%) had eaten animal matter, but 18 (81.8%) had also eaten plant matter. In no instance were the large masses of vegetable matter typical of the larger fish found in the smaller ones.

The type of animal food also varied with the size of the fish. The small fish were as prone to feed on aquatic insect larvae (13 specimens, or 59.1%) as on terrestrial insects (15 specimens, or 51.9%). Almost all of the animal food taken by the large fish consisted of terrestrial insects (5 specimens, or 27.8%). No aquatic insect larvae were found in the stomachs of the large fish, although two of them (11.1%) had eaten aquatic crabs, which were not consumed by the smaller fish.

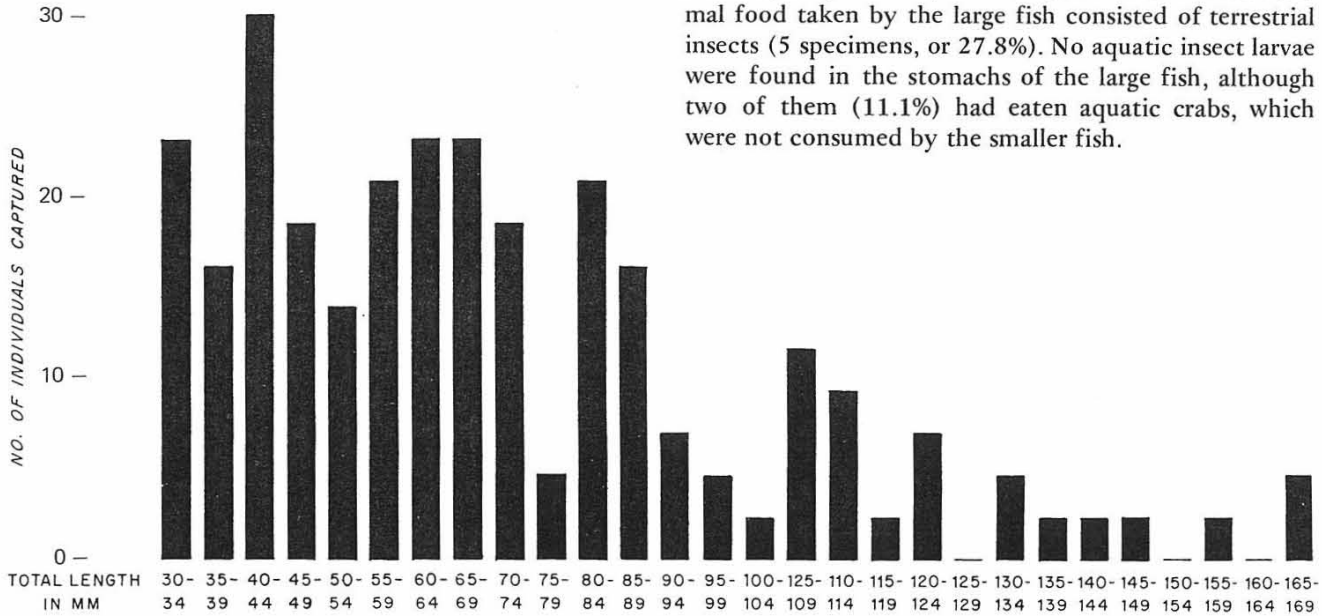


FIG. 3

The principal vegetable constituent in the diet of the large fish was tree leaves (13 specimens, or 72.2%), which were always found shredded into small triangular pieces. Apparently the unusual three-lobed teeth of *Brycon* spp.

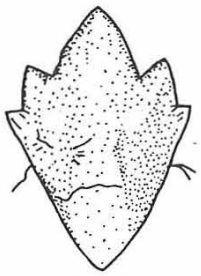


FIG. 4

(Figure 4) are an adaptation for this function. Other plant foods consisted of fruit and seeds (12 individuals, or 66.7%) and other parts, including stems, flowers, roots, and bark (5 specimens, or 27.8%). The absence of aquatic plants in the diet reflects the absence of such plants in the Tirimbina.

Only one of the smaller fish was found to have shredded leaves in its stomach, although four specimens (22.2%) contained single leaves. Other types of plant material were proportionally more important, as seven specimens (31.9%) contained fruit and/or seeds, while the same number contained other types of plant remains.

These data are in agreement with the observations of Lowe (1964) and Menezes (1969). Lowe observed *B. falcatus* in British Guiana to feed on fruit and flowers which dropped into the water from overhanging branches. Menezes studied the food habits of *B. chagrensis* and *B. petrosus* from the Canal Zone and Honduras. He found that 80.0 and 85.7% of the food, respectively, of these two species was of vegetable origin, with the remainder being made up entirely or almost entirely of aquatic insect larvae.

Although fishermen on the Rio Tirimbina believe, apparently erroneously, the *B. guatemalensis* feeds on small fish, while de Gil (1949) reported that artificial minnows were used by anglers to take *B. orbignyanus* in Argentina, Menezes' (1969) statement that *"All species in this genus show a strong preference for plant material"* seems generally acceptable.

BEHAVIOR AND HABITAT PREFERENCE

No concerted attempt was made to study the behavior of *B. guatemalensis,* but a few observations were made which may be of interest:

B. guatemalensis of all sizes were found chiefly in pools or in swift-flowing but flat-topped water. Rarely were they found in riffles and then usually only as transients. The larger individuals seldom ventured far from cover and seemed particularly fond of undercut banks.

Ample cover did not seem requisite for smaller individuals, which were often found in quite exposed locations. At first glance, small *B. guatemalensis* appeared to occur in mixed groups with *Astyanax fasciatus,* but further observation indicated that *B. guatemalensis* was found mainly in the lower reaches of pools, while *A. fasciatus* were concentrated near the heads. In one instance, a seine haul made at the tail of a pool yielded 14 *B. guatemalensis* and three *A. fasciatus;* a subsequent haul at the head of the same pool brought up one *B. guatemalensis* and 12 *A. fasciatus.* This informal experiment was not repeated, but was corroborated by rough counts taken while diving.

B. guatemalensis of all sizes were more active and more apt to be in open water during the hours just after dawn and just before dusk than at any other time. A few attempts were made to observe them at night, but there was no indication of any activity during darkness. On a few days, individuals or groups were seen feeding or rest-

TABLE 2

Occurrence of Food Types in Brycon guatemalensis Stomachs

		Terrestrial Plants				Aquatic Insects				
Length Range (mm)	No. of Fish	Leaves	Fruit & Seeds	Other Parts	Total Terrestrial Plants	Kitchen Refuse (vegetable)	Odonata (Dragonflies & Damselflies)	Coleoptera (Beetles)	Ephemeroptera (Mayflies)	Total Aquatic Insects
61-178	22	4(18.2%)	7(31.9)	7(31.9)	13(59.1)	8(36.4)	3(13.7)	5(22.7)	10(45.5)	13(59.1)
183-400	18	13(72.2)	12(66.7)	5(27.8)	17(94.4)	2(11.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)

	Terrestrial Insects								
Hymenoptera (Ants, Wasps, Etc.)	Coleoptera (Beetles)	Lepidoptera (Butterflies & Moths)	Orthoptera (Grasshoppers, Etc.)	Unidentified	Total Terrestrial Insects	Crustacea (Crabs, Potamon)	Total with Vegetable Food	Total with Animal Food	Mud & Gravel	Stomach Empty
6(27.3)	4(18.2)	0(0.0)	0(0.0)	9(40.9)	15(51.9)	0(0.0)	18(81.8)	20(90.9)	1(4.5)	0(0.0)
2(11.1)	2(11.1)	1(5.6)	1(5.6)	0	5(27.8)	2(11.1)	17(94.4)	6(33.3)	2(11.1)	1(5.6)

ing in open water during the hours of bright sunlight, but typical mid-day activity consisted chiefly of nervous darts from cover through open water and back to cover; this was usually done by groups of 2-10 fish. Toward the end of the study period it became common to see individuals dashing through a pool at full speed, rolling and flashing their sides; this may have been connected with the approach of the spawning season. A more frequently observed mid-day behavior was migration through riffles from pool to pool. This was always done in groups of five fish or more, and always at a very high rate of speed.

Many attempts were made to observe feeding behavior, by diving and from the bank. All that was seen was *B. guatemalensis* taking floating insects or other small food items. There was never an opportunity to observe the supposed shredding action of the teeth.

There was little indication of social organization.

POND STOCKING EXPERIMENT

B. guatemalensis, and *Brycon* spp. in general, are characteristically river fishes and, so far as is known, are not native to standing waters. However, it does not necessarily follow that they will not survive in ponds and lakes. The various Chinese carps, which have been cultured in ponds for thousands of years, are not known as wild fishes from such habitats. It may be that *Brycon* spp., like the Chinese carps, are absent from ponds and lakes not because they cannot survive in them, but because they require running water to reproduce.

An indication that *B. guatemalensis* can survive in standing water was given in February, 1973, when a large metal tank located on the bank of the Rio Tirimbina was drained. The tank had been stocked in August, 1972, with an assortment of river fishes, including a number of supposed *Astyanax fasciatus.* These fish had been nelected and largely forgotten; the water in the tank was stagnant, rusty to the degree that visibility was less than 55 mm (2 inches) and undoubtedly considerably warmer than river water. No food had been provided except for such leaves and insects as fell into the tank. Several of the *A. fasciatus,* plus one 80 mm (3 inch) *B. guatemalensis* were found, emaciated but alive.

One experiment in stocking a small, shallow, mud bottom pond with *B. guatemalensis* was carried out. The pond, located at Granjas Tropicales, within a few minutes walk of the Rio Tirimbina study area, had previously been stocked with *Tilapia* sp., and a few of these fish remained, along with a few *Rivulus isthmensis.* There was a small flow of water through the pond, but it was certainly stagnant in comparison with the river, and water temperatures during the study period ran 28-32°C (82-90°F) - considerably higher than in the river.

Beginning 2/23 and lasting through 3/11, *B. guatemalensis* in the length range 30-165 mm (1-6.5 inches), captured in the course of the length-frequency study, were stocked in the pond. These fish were placed in plastic buckets immediately upon capture and transported to the pond as rapidly as possible. The buckets were covered and floated in the pond until the water temperatures inside and outside were equalized, then the fish were released. At first there was nearly 50% mortality owing to the nervous temperament of the fish, which repeatedly leaped and battered themselves against the sides and cover of the bucket. Later it was found that a few large leaves floated on the water surface greatly reduced the incidence of leaping, and mortality was reduced to around 10%. This mortality was largely confined to 30-40 mm (1-1.5 inch) fish, which were very fragile with respect to handling.

The only fish from these stockings which was sighted again was a ca. 65 mm (2.5 inch) specimen seen on 3/3. Since the last stocking previous to that date was on 2/26, this individual had survived at least five days. Repeated attempts were made to observe other *B. guatemalensis* in the pond as late as 3/30, but to no avail. Attempts were made with flashlights at night, when characins are normally inactive, as well as during the day.

There are four possible explanations for the disappearance of the stocked fish. One is that they found the habitat unsuitable and died. This appears unlikely in the light of the anecdotes above and in view of the fact that no dead specimens were ever found. It is also possible that they were present, but never seen. This also seems unlikely, since many *Tilapia* sp. could readily be seen at night, and three *Rivulus isthmensis,* by nature a secretive fish, were observed. It seems more likely that the stocked fish were eaten by predators (the pond was relatively devoid of cover); or perhaps they escaped. The pond has no inlet, but does have a small outlet. The outlet was screened, but perhaps not adequately.

It is my opinion that *Brycon* spp. will eventually be shown to survive well in standing water. The crude stocking experiment of 1973 should be repeated under better conditions.

EDIBILITY AND PREPARATION

Brycon spp. have one disadvantage as food fishes; they are very bony. Facilities for cooking experiments at Tirimbina were limited, but a few methods of frying *B. guatemalensis* were tried and the acceptance of the product noted.

Small specimens (under 100 mm - 4 inches) were gutted, headed and fried until the bones became brittle and could be chewed up along with the flesh. The result was a crispy "fish chip" which was liked by all who tried it. Some judged them to be superior to *Astyanax fasciatus* prepared in the same manner.

Larger specimens were sometimes fried in the normal manner and sometimes chopped up in small pieces and cooked as though they were small fish, that is until the bones were brittle. Everyone agreed that fish cooked by the former method were tasty, but several individuals found the bones objectionable. The other frying method produced no objection from anyone.

The subjects in the above observations were all North Americans, but the local people also make use of *B.*

guatemalensis as a food fish. They agree with the North Americans who have tried it that the flesh is excellent. No complaints of boniness were heard from Tirimbina residents who preferred *B. guatemalensis* to such other local species as *Cichlasoma tuba* which was equally available and less bony.

SUITABILITY FOR CULTURE

The work described here is of course only the beginning of evaluation of *B. guatemalensis* as a cultured food fish. It is already possible, however, to outline some of its advantages and disadvantages for this purpose:

Advantages:

1. Low position on the food chain, enabling it to be fed cheaply.
2. Utilization of readily available foods which are not wanted for other purposes (i. e. tree leaves) or to feed other fishes.
3. High quality of flesh.
4. Acceptability to Costa Ricans as a food fish.
5. Probable ease of breeding.

Disadvantages:

1. Lack of knowledge of behavior and ecology.
2. Boniness
3. Nervous temperament and delicacy of small specimens with regard to handling.

In my opinion, the known advantages outweigh the disadvantages, and the potential for culture of *B. guatemalensis,* either as a mono-crop or as one component of an analog of Chinese pond polyculture, is great. We should be beginning to attempt the culture of this species, while at the same time pursuing further investigations of the behavior and ecology of the wild form.

SUGGESTIONS FOR FURTHER STUDY

The following very briefly outlined projects were suggested by my work on the Rio Tirimbina in 1973.

1. *Age and growth of B. guatemalensis:* This would involve capturing, measuring, marking and releasing a large number of *B. guatemalensis,* then attempting to recapture and remeasure them over a long period of time, so that natural growth rates could be established. This study could be combined with a population estimate with no increase in physical labor.

2. *Ecological niches of B. guatemalensis and Astyanax fasciatus:* This study could begin with more extensive seining and diving observations of the sort reported here, which suggested that the two species are found in the tail and head of pools, respectively. It could be extended to observations of the diet, behavior, etc. until the niches of these similar species can be defined.

3. *Breeding habits in nature:* Attempts should be made to observe the spawning of *B. guatemalensis.* Should high water preclude this, it would nonetheless be valuable to know the size, date, and place of occurrence of ripe adults, drifting eggs, and/or early fry.

4. *Breeding in captivity:* Attempts should be made to reproduce *B. guatemalensis* in captivity by the methods suggested in the text. Correspondence with Brazilian fish culturists, who regularly breed many species of characins, would be in order.

5. *Pond stocking:* The 1973 pond stocking experiment should be repeated under better conditions.

6. *Food chain studies:* The food habits of *B. guatemalensis* and other fishes of small Costa Rican streams like the Rio Tirimbina should be further examined and compared with data from larger streams in the area or with temperate zone waters. It appears that the amount of fish food originating terrestrially is extremely high in small tropical streams, a piece of information which may have implications for aquaculturists or anyone else concerned with the fate of tropical ecosystems.

7. *Feeding behavior of B. guatemalensis:* If possible, *B. guatemalensis* should be observed in the act of feeding on plant materials. This could involve field observation or aquarium work. In addition to defining the manner in which the unusual teeth of *Brycon* spp. function, this study could also be used to test food preference.

8. *Cage culture:* Wire cages could be anchored in a small stream such as the Tirimbina and stocked with *B. guatemalensis.* These fish could be fed various diets and their growth compared to that of wild fish. A problem here could be high water.

ACKNOWLEDGEMENTS

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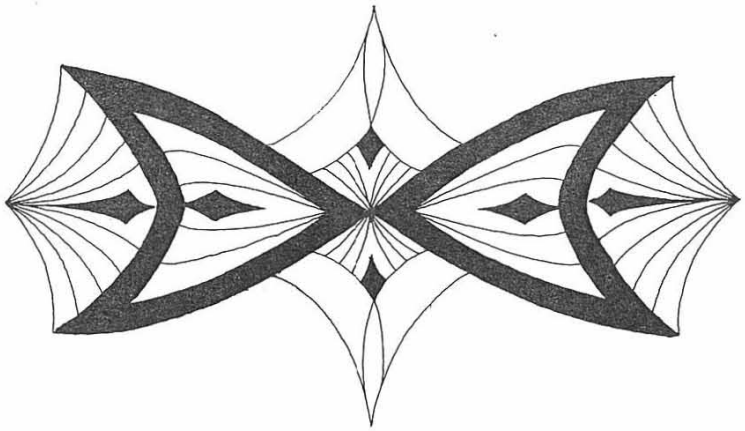
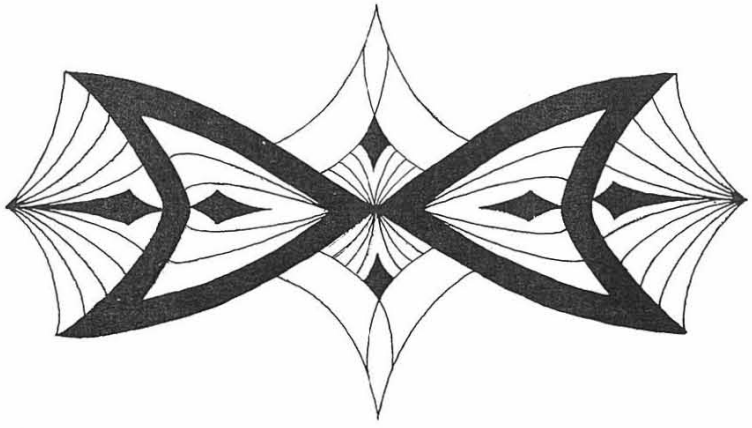
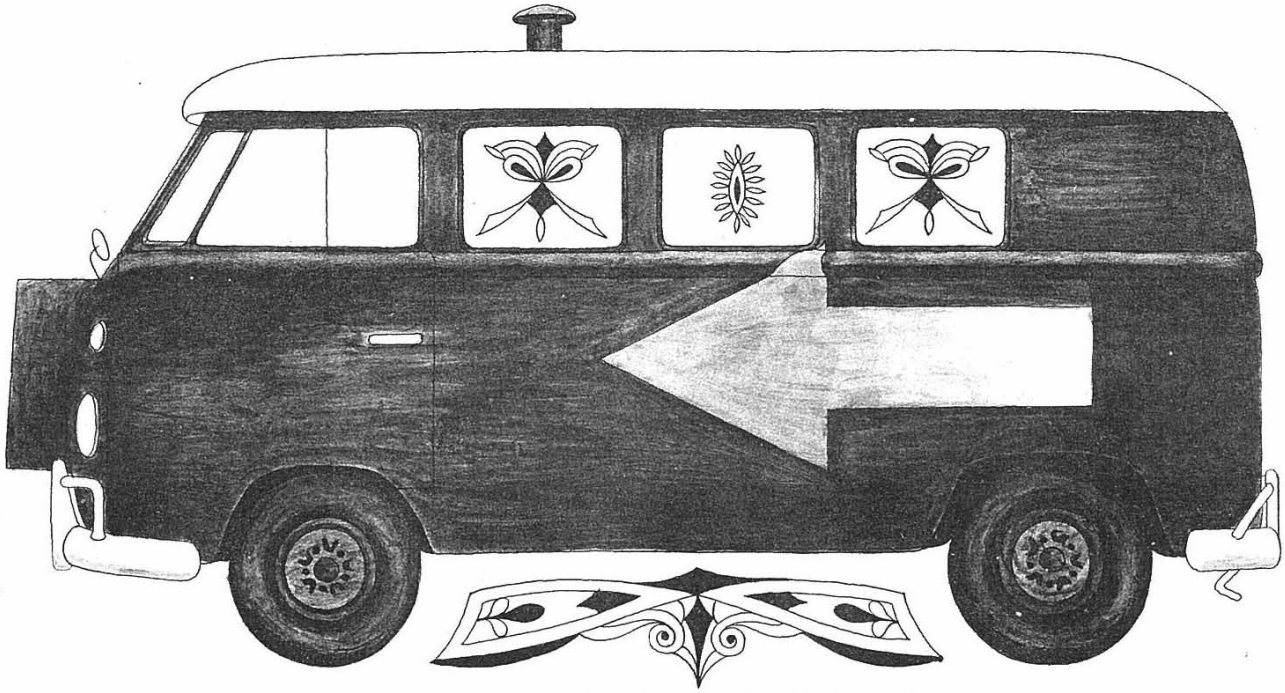


Explorations



This first section of **Explorations** *describes travel in psychic, geographic and historical space. In the last* **Newsletter** *we told of the departure of the first Earth Gypsies when David and Laura left on their rambling journey. Now each of them can tell of their reactions to what they saw and felt. It is good to see their freaky camper which Camas has drawn so well beside the battered New Alchemy truck again.*



It is a strange coincidence that the article that follows by Will Wroth was born in the same area that affected both Laura and Dave so profoundly. In many ways it parallels John Todd's in that it tells the story of a decline of a landscape and a culture. It is particularly interesting because it happened so recently and in this country and is therefore a readily traced and tragic example of annihilation in the name of manifest destiny.

We are not planning to concentrate solely on material that will induce a state of unmitigated gloom. A recent visitor who spends a great deal of time keeping a finger on the pulse of the state of alternative ideas has promised a report on some of the ingenious approaches that both urban and rural people have developed to survive in the jaws of the technological monster. We hope to explore Fen Shui, the ancient Chinese science of wind and water, and to hear from friends who are either travelling or developing similar communities. Sometimes in this section we will include our fantasies, and we have many. For this time, thoughts born in the mountains of New Mexico.

Earth Gypsies

"Earth gypsies" we were called in a previous New Alchemy newsletter and at the time I had to smile at the ultra-romanticism of it all. Who, us? Yet now as I feel my way back to those days on the road the inevitable nostalgia makes the term seem appropriate after all.

For three months Dave and I and our feline friend enjoyed the freedom of "life on wheels". We had no obligations, no schedules to fill, nothing to anchor us to any particular time, place or situation. I often felt we were just free-spirits, flowing in and out of a myriad of different realities, feeling what was there, giving what felt appropriate of ourselves, and then moving on.

We saw so much, yet so little. It's hard to give valid impressions of "what was out there" between East and West. What I feel so deeply is that the earth is incredibly alive where we have allowed her to breathe. Her mountains, deserts and wilderness areas reveal a magic that must be experienced to be known. As one pretty far-out member of the New Buffalo commune said of the Sangre de Cristos, "People either find a way to channel the energy creatively or get freaked out and go away."

Each natural environment has its own characteristic vibration of varying intensity which is reflected in the people who live, or try to survive, there. For example, communes in the Taos area of northern New Mexico are very different from each other in goals, structures, and even lifestyles, yet those that we visited all exhibited that rugged individualistic intensity that paralleled the roughness of the land. In contrast, as we pulled into southern California, the aura changed completely. Here the land was overridden with people, automobiles and architecture. The city vibration, to me, was chaotic, uptight, and very superficial. Even the ocean beside the urban areas seemed dull and lifeless. Later, as we left and drove north towards Big Sur, I was relieved to feel the magic of land and sea returning in full force.

Once our lack of funds forced us to assume a more stationary existence, we felt ourselves gravitating away from the city and back towards Cape Cod. New Alchemy-East has proved to be a fine home base for continuing our personal head trips and combining our energies with others. Though the farm has roots, not wheels, "earth gypsies" are we all, seeking the roads towards greater unity with our planet.

— Laura

We traveled close to nature, warmed by a necessary pot-bellied stove in our aging VW bus. I delighted in learning about wood and basic gathering to provide a warm home in the snow-covered mountains. A lesson soon encountered emphasized man's current lack of understanding in the basic technology that propels him. I became both friend and foe to our "wheels", guided in maintenance by John Muir's "VW Manual for the Complete Idiot". The resulting mobility allowed us to drive the necessary altitudes to arrive one sunny morning in Truchas, New Mexico. Here in a setting of adobe houses and animal skulls, artist Bill Tate rambled on about an earlier visit by John Muir with his VW bus and teepee. How supportive we all become, directly and indirectly, of each other in our cycles of living!

Occasionally these threads of experience were interrupted by my demand for a scientific understanding of alternative cultures. What of alternatives are there in the jagged perspective of a rough country, rugged in its silence, yet demanding direct awareness of the uniqueness of every living thing that is connected by a struggle for survival? What of organic farming, communal living, ecology, commitment, the planet, the universe? Is man too bent upon his logic of structure and definition to answer himself? And can communication allow a group expression of alternatives?

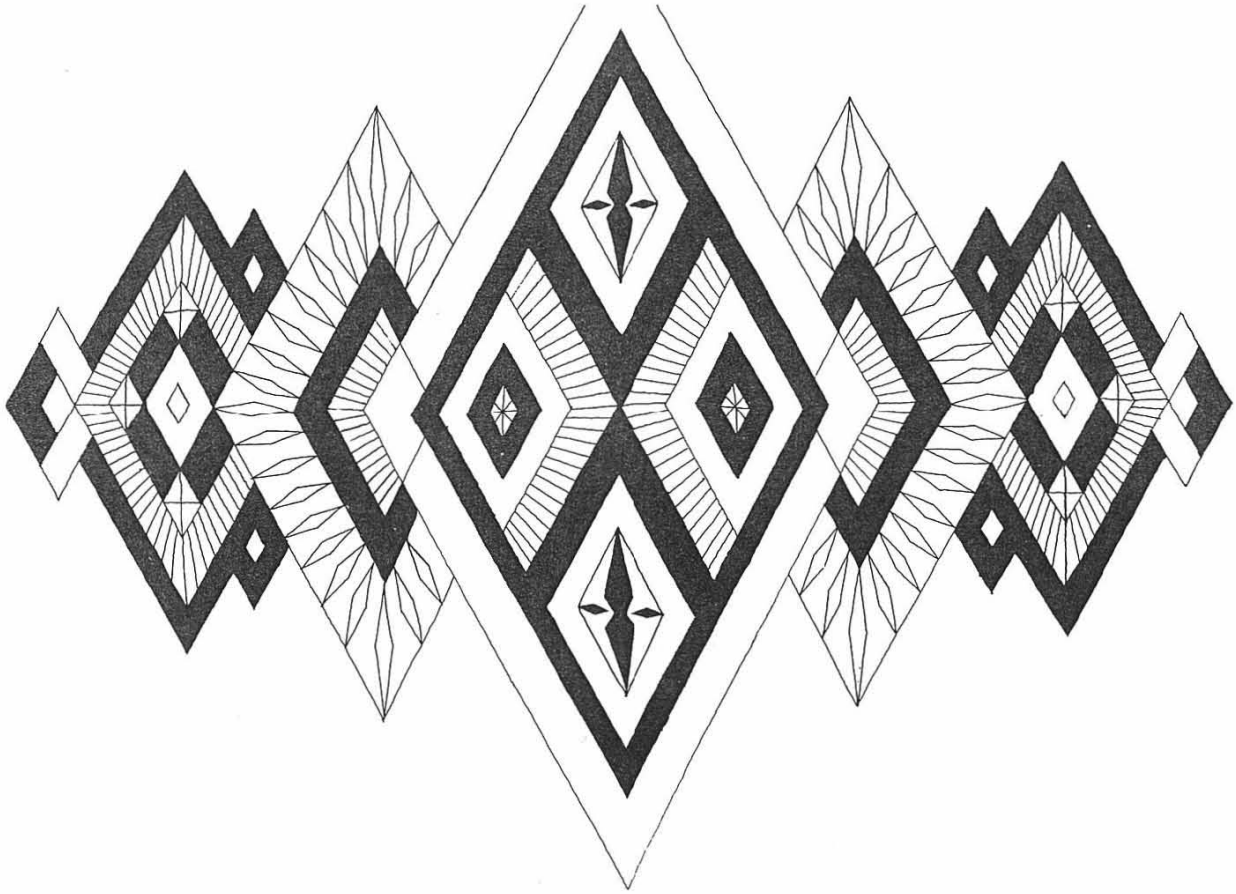
Alternatives are perhaps chosen out of a myriad of dissatisfactions, but are themselves difficult to define. We picked up a young black hitchhiker and asked him where he was going with his gym bag and golf hat. He said that he didn't know where he was going.... out west somewhere. We parted and headed south into Colorado. Boom towns have erupted in this state, attesting to the popularity of ski sports. Wood is imported for condominiums, and prices for food and lodging are incredibly high. The abandoned mines still haunt the passes, not yet replaced by tow bars and fad architecture. Yet nature, specifically the mountains, drew us close in our confusion to share her secrets. Circles in the skies swirled in a visual tapestry suggestive of the liquid noise level of inner space. Ecology thus entered the fourth dimension of vibrations. We avoided the boom towns.

The land was primary in providing a basis of my consciousness of the events surrounding my perspective. Some impressions were complex hallucinations of energy carried effortlessly within the winds of the desert. Other people became amplified by a mutual respect for the surrounding environment. I met one woman in a commune's group outhouse while I was gazing at the moon. At the top of a saddleback, Robin Hood fantasies complete with paranoia persisted in the jungle fatigues of a couple of universal soldiers. There were so many trips supported by everything from creativity to welfare to occasional agriculture. Within this variability, the rituals of prayer and group feasting were a refuge, a chance to rest within the safety of human understanding.

Occasionally I would meet an individual with a deep understanding of his life alternative. Then the energy of a crackling fire would flow between us and there would be no need to speak further. This is the reinforcement, the fantasy of a community based upon sensitivity, capability, and perceptions with love of fellow human beings. The forces are dynamic, however, and the "group" of one, two, or more becomes cosmic only to later fade away. The individual, however, leaves with a piece of knowledge to build his alternative. Evolution continues.

Laura and I grew separately, together, and traveled on.

— David



traditional ways in new mexico villages

I. Z. is a Spanish-American village in the Sangre de Cristos mountains of New Mexico, north of Santa Fe. It was founded over 200 years ago as a military outpost to protect the farming communities of the valleys from Indian raids. The present population of Z. is almost entirely descended from the original settlers and the Pueblo indians who formerly inhabited the area. Among themselves they speak Spanish. Until the last few years no more than one or two Anglos were living in the village. Due to its mountain isolation and fairly severe climate, Z. has maintained to the present day more of the traditional Spanish-American culture than most New Mexican villages.

Prior to World War II, Z. was almost totally independent of Anglo-American culture and economy. Separated by 9 miles of steep mountain dirt road which was impassable or close to it many months of the year, Z. (and other similar mountain communities in the area) was virtually a money-less economy. The people were self-sufficient to a degree that is unknown anywhere else in present day U. S. They grew all their own food: yellow, white and blue corn, wheat, beans and squash were staples. Goat herds ranged in the hundreds and everyone kept them. Today the largest goat herd in Z. is 30. Sheep were also abundant and some cattle. All available land was farmed and an elaborate system of irrigation ditches and ponds was used to maintain sufficient moisture in this dry climate. The traditional irrigation system and the methods of water allotment and water conservation are still in use in Z. today and are exactly the same systems developed by the Moors in Spain. In addition the Moors in their development of the art of agriculture practiced the "rule of return" of all organic matter back into the soil (via composting), and the terracing of fields for maximum land utilization and preservation of topsoil[1]. Both practices were in use in Z. until recent years. Even today horse and cow manure are the standard fertilizers. Most Spanish and Indian farmers in the area are intuitively suspicious of chemical fertilizers, knowing that they are unnatural and bad for the soil. The remains of beautifully terraced fields may be seen all over this part of the country, but the practice has

[1]The Moorish-Hispano art of agriculture is outlined in detail by G. T. Wrench, *Reconstruction by Way of the Soil.*

almost died out because so little of the available land is now being farmed.

The village water system also provided a convenient source of power. Z. formerly had many flour mills along the *Asequia madre* (Mother ditch). These mills took water from the ditch (by means of a long spillway to develop pressure) to drive a horizontal water wheel on a long vertical axle which in turn drove one of the mill stones. There are in Z. two of these *molinos* remaining but not in operation[2]. Water power was also used for saw mills but this was mainly a commercial operation.

Until the last 20 years or so, nearly all farming was done by hand. Internal combustion machines were rare. Plows and harrows and hay wagons were all horse-drawn. Fields were planted, watered, weeded and harvested by hand. Grain and corn were hand threshed; beans were threshed by horses walking in circles over a hard adobe threshing floor, usually outdoors, crushing the pods and stalks. Z. villagers maintained (and some still do) their agricultural self-sufficiency throughout the year by canning and by drying some fruits and vegetables and by storing others in root cellars. Chickens were kept; pigs were slaughtered for lard. Beef was dried in the sun to make *carne seca.*

In Z. and other Sangre de Cristo villages self-sufficiency extended beyond the realm of agriculture to all the other concerns of life. Weaving and clothes making were highly developed. The village of C. 9 miles from Z. has long been famous for its weavers. Today there are two active weaving shops in C. and two have recently been started in Z. but these are commercial operations dependent on selling to outsiders. Few local people can afford to buy these elegant handwoven articles. The same situation exists for the traditional craft of furniture making. The little furniture now being made is sold to outsiders. But the older Spanish people still have in their houses many beautiful pieces of handmade furniture.

Building construction was a necessary task and today most of the men and women still know how to work with adobe. Bricks are still made by hand in wooden forms from a careful mixture of mud, gravel and straw. Although modern construction methods are generally gaining popularity, adobe houses are still being built and older ones are carefully maintained, usually by the women. Good exterior maintenance requires the woman of the house to plaster the bricks every year with a layer of adobe of exactly the same composition as the bricks themselves. Interiors traditionally were whitewashed with a mixture of lime which is available locally and wheat flour or other suitable binding agent - now of course commercial whitewash or latex paints are commonly used.

Pottery was made in Z. as it was in all Spanish and Indian communities in the area. Z. potters produced a very nice low-fired grayish-black pot flecked with tiny flakes of mica. There are very few of these pots still to be found in Z. and the last potter died many years ago - another lost art.

Metal working has survived in the form of blacksmithing. Several men in town are competent smiths and their services are still sought. Forges are still operated with hand blowers. Examples of traditional ornamental metal work can be seen in picture frames made of sheet metal cut to form with geometric patterns punched in.

Due to their remoteness, Z. and other villages had to take care of their own medical needs. Even today there are villages in the area which are 20 or 30 miles of bad road away from the nearest doctor. Every village had its own *curanderas,* women who knew how to prepare medicines from the wild plants for every conceivable illness. These women also served as midwives and delivered all the babies. Some of them also were skillful masseuses. There is one of these women now living in the area, a bright-eyed, energetic lady of 84. She still practices her art - preparing medicines from local plants - and has many patients among the older generation, while the younger seem to prefer aspirin and city doctors. She also continues to deliver babies - when there is an expectant mother brave enough to have her baby at home, without doctor, hospital or anesthesia.

The remoteness of Sangre de Cristos villages also contributed to the development of an indigenous form of religion, *Los Hermanos Penitentes.* The Penitente Brotherhood is a form of folk Catholicism which developed in this area because of the lack of formal church hierarchy. For long periods in the 17th and 18th Centuries there were neither priests nor a bishop in New Mexico. The main transmitters of Catholicism were Franciscan monks. It is believed that the Penitentes derived from the 3rd order of the Franciscans of Medieval Spain[3].

Whatever its origin, it became the only religion of these Spanish villages. There were no priests; services were led by a group of elder Brothers singing and chanting. The Penitentes emphasized suffering as the way of purification and redemption. The suffering of Christ was re-enacted each year at Easter time. There has been much-to-do by modern writers about the so-called "barbaric" sufferings the Penitentes put themselves through and thus they have gained the reputation (in part fostered by the Church) as being a malevolent deviant cult. In truth, however, the physical suffering was voluntary and willingly taken on as a means of purification and of working out karma. Further, it was limited in time to a few days of the year in the week before Easter. The Peni-

[2]I have heard of a similar *molino* in Taos county recently put back into operation by its Spanish owners.

[3]Many Penitente practices show a close affinity to those prevalent in Medieval Europe. For instance: the singing and chanting and musical instruments used during Easter week. One instrument the *matraca* or cog rattle, had exactly the same use in Medieval Europe as it does now during Easter week in Penitente ceremonies. (cf. A. Baines, ed. *Musical Instruments through the Ages,* London, 1961.)

tentes functioned throughout the rest of the year as the spiritual and moral backbone of the community, resolving conflict and generally taking care of the needs and problems of the people. The sense of community that remains in Z. and other New Mexican Spanish villages can in large part be attributed to the past and continuing presence of the Penitentes who today are the village elders. The actual ceremonies of the Penitentes are very simple and beautiful, certainly one of the purest forms of Christian worship in America today.

The Penitentes today operate to a large extent "underground" and are said to be dying out. The flagellant and self-mortification aspects of their Easter week ceremonies have been toned down or perhaps are now performed in secret. Modern America has become too bland to accept such deeply-felt and acted spirituality which in my mind makes their continued existence all the more important. We are used to all kinds of horrible destructive acts in America - they are easily rationalized, but any positive act involving pain is unthinkable. It is unthinkable because expiation and purification by means of suffering is exactly what the self-indulgent American ego needs the most.[4]

II. At the present there are still many vestiges of traditional culture in New Mexico Spanish mountain villages. In Z. the transition to modern American culture began with the paving of the highway and the development of Los Alamos during World War II. Los Alamos requires all kinds of blue collar workers and the pay-scale is equal to the highest in the nation - in one of the lowest income, "economically depressed" areas of the country. Rapid transportation, World War II and the lure of dollars at Los Alamos and other cities took the men of Z. away from their traditional way of life: many have left for the cities and have not come back. The population has dropped from 1700 to 400 in 40 years, fields lie fallow from one end of town to the other. The few crops that are grown are mainly for animal feed or for sale, not for local consumption. Fruit trees are neglected, the *molinos* are no longer in use. People are content with bleached white-flour bread and canned fruit and vegetables from the supermarket.

Money is being made, houses have been transformed from Spanish adobe to suburban American. New cars wander aimlessly up and down the roads on weekends (on weekdays their owners are busy working to make the payments). The young people are bored and have nothing to do in Z. so they get drunk or go the cities to work.

It seems incredible to watch these people rushing to emulate white American material culture which to us and our friends has proven to be so empty and valueless. Informants tell us the community spirit that once existed in Z. was really strong. People felt a sense of duty to help their neighbors. Now with everyone off on their individual work and money trips, families are starting to grow more distant from one another, and one senses that the human isolation typical of white America is rapidly approaching here.

In Z. the deadening uniformity of modern America is evident in many areas: diversified crop and animal farming for sustenance has degenerated to cattle raising mainly for cash - with the inevitable dire consequences to the land. The existing farm land is being ruined by overgrazing of cattle and mono-crop growing of alfalfa. The result is soil depletion and weakened grass root structure, causing arroyo cutting and widespread erosion. Not only is the existing land being ruined, the Department of Agriculture is destroying valuable forest land, leveling thousands and thousands of acres of trees to make more grazing land for more cattle. The result is inevitably a decrease in rainfall in the affected areas where low rainfall is already a serious problem.

The homogenous Anglo-American material culture approaches Spanish New Mexico from many directions: cultural sterility via television, prepared food monotony via supermarkets, the bland piousness of Protestantism and modern Catholicism replacing the Penitentes. There is much talk of preserving Spanish cultural traditions but at the same time there is whole-hog adoption of Anglo-American values. Spanish is taught in the schools only as a foreign language.

These changes have the one advantage of being very recent. There are still many old people in town who have not changed at all: they speak little or no English, live in simple houses without electricity and running water. Walking is their form of transportation and they use horses for farming. These old people are the last representatives of traditional Spanish-American way of life. Their children and grandchildren have almost entirely given it up. Away from Z. in cities like Los Alamos, Santa Fe and Albuquerque many young people no longer speak or care to speak Spanish.

The recentness of these changes allows us access to traditional ways. Even the sons and daughters (people in their 30's, 40's and 50's, who work in the cities) are clearly aware of "the way things used to be" and there are not many who would say things are better now.

III. A recent phenomenon in Spanish New Mexico is the arrival of a new group of people: young Anglo-Americans who have become disenchanted with modern American material-technological culture and are seeking a simpler way of life.

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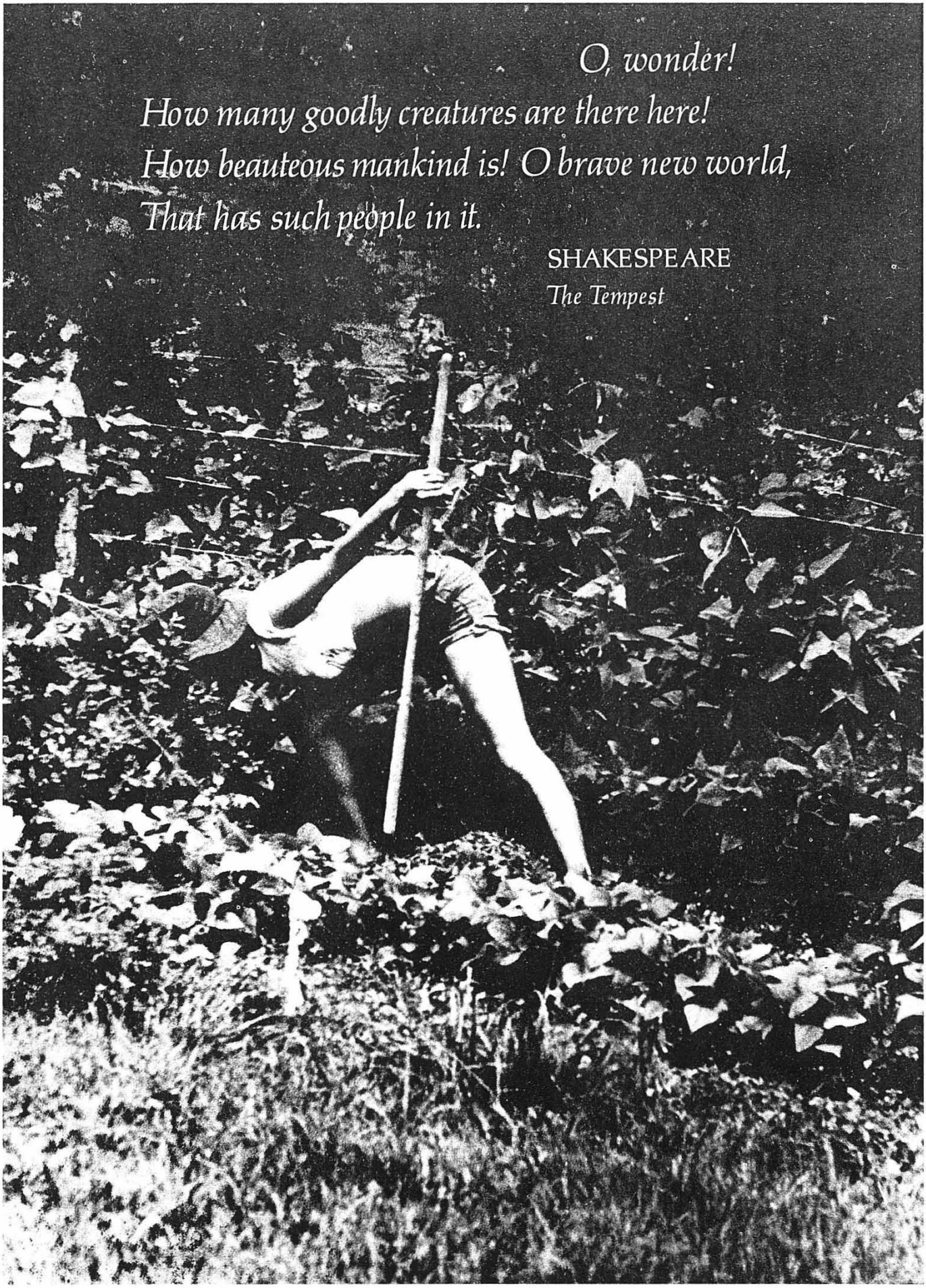
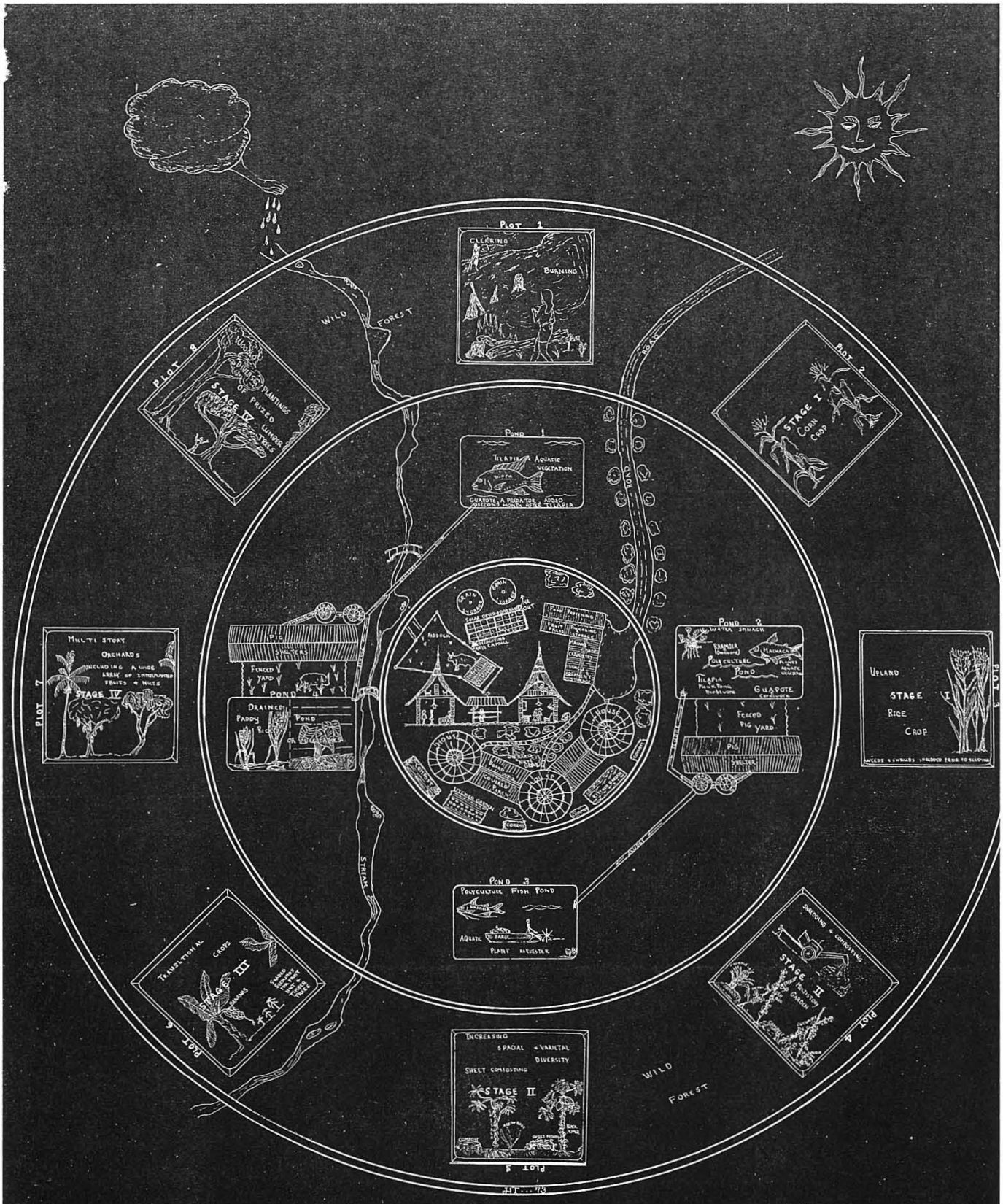
[4]cf. *An Interlinear to Cabeza de Vaca* trans. by Haniel Long (1935; Frontier Press, 1970). The incredible relation of a 16th century Conquistador who was shipwrecked on the Florida coast and walked from there to New Mexico undergoing terrific hardships and sufferings beyond anything modern man can imagine. The result of these trials was enlightenment and realization of the common plight of all mankind. The Conquistador mentality transformed by *suffering* to a higher level of consciousness.

This heavy influx of young people in the last few years has not been without problems: there has been tension and some conflict between Spanish residents and new arrivals, but now after nearly four years things are beginning to settle down. The young people who have stayed have become more attuned to Spanish ways. Most of the bad elements among them have gone back to the cities. It is not easy to live in this northern New Mexican country, the land is harsh and people who are not really together have not been able to stay. The ones who have stayed have bought land and built homes. They are beginning to work the land, growing their own vegetables and taking care of some livestock. A "hip" community has grown up extending from Santa Fe to Southern Colorado and includes several large communes and many single and extended families.

Some of us are really concerned to see this community achieve a high degree of self-sufficiency. Agricultural self-sufficiency seems to be a basic first step. The difficulties here are lack of water and a short growing season but people are learning the basics of gardening, farming and caring for animals. There are now several outlets for local produce: co-ops, natural foods stores and farmers' markets all of which encourage people to produce surplus for sale or trade. Besides garden vegetables we are learning to grow grinding corn (white, yellow, blue); wheat, oats and buckwheat; peas and beans (kidneys, pintos, bolitos); and are raising goats for milk, cheese and meat, and poultry for eggs and meat. These staples we hope will eventually provide year-around self-sufficiency for a large community of people.

— *Will Wroth*
June 1971


O, wonder!
How many goodly creatures are there here!
How beauteous mankind is! O brave new world,
That has such people in it.
SHAKESPEARE
The Tempest



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