



WAD'S WORDS - NEW IDEAS

all are about process, not structure

- GENETIC ASSIMILATION
- CHREOD
- EPIGENETICS and
- EPIGENETIC LANDSCAPE
- CANALISATION
- HOMEORHESIS

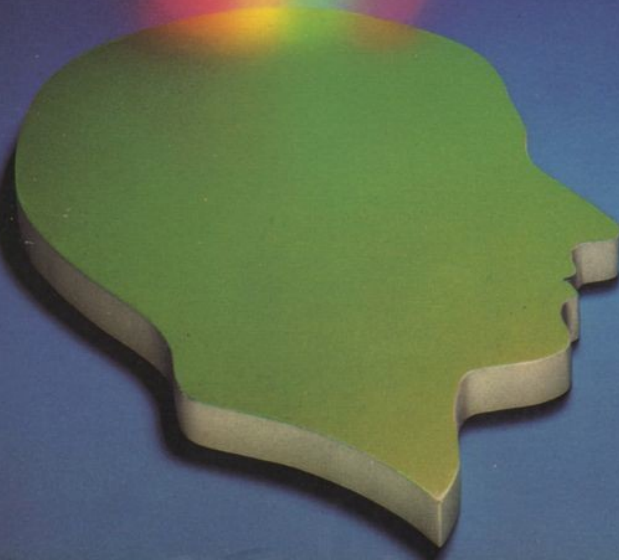
- **COWDUNG**

being the COnventional Wisdom of the
DomiNant GroUp

C.H. Waddington

TOOLS FOR THOUGHT

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PALADIN

PELICAN
BOOKS

THE SCIENTIFIC ATTITUDE

REVISED EDITION

C.H. WADDINGTON



One shilling and sixpence

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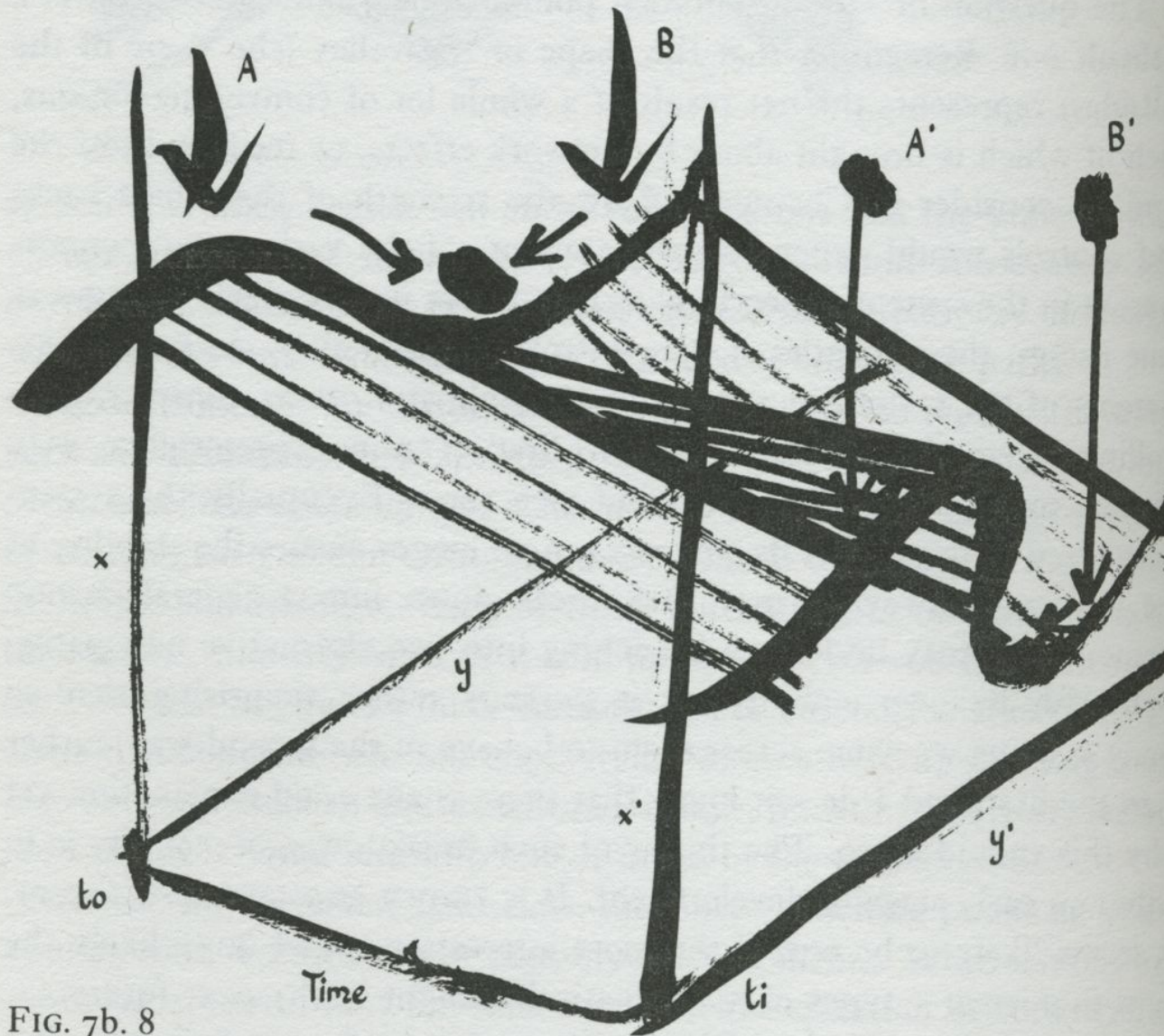


FIG. 7b. 8

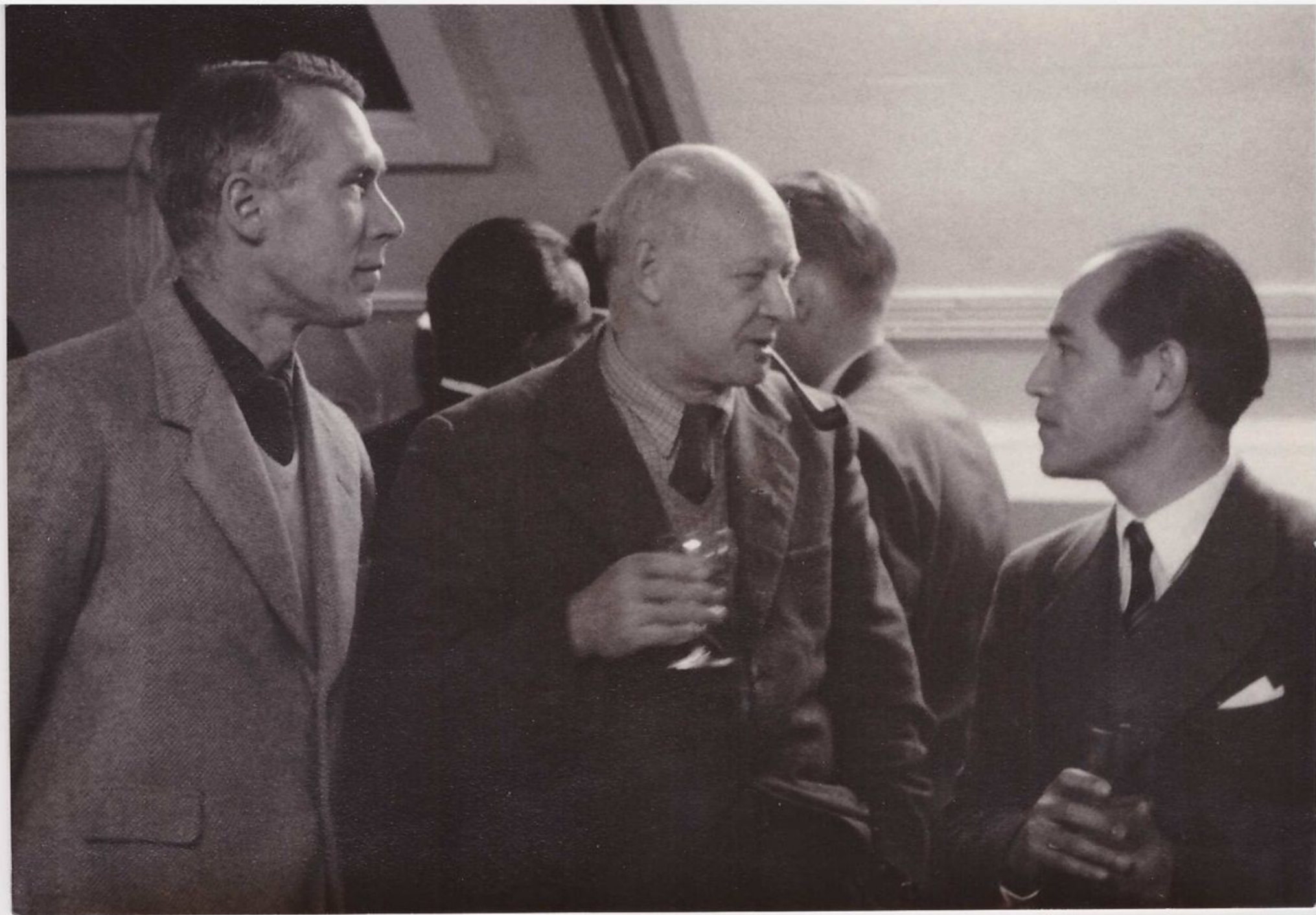
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Biology
and the
History
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Future



Centre for Human Ecology

“We are convinced that there is a *prima facie* case for the University establishing a Centre for Human Ecology”

“this area of study involves too many disciplines”
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WADDINGTON'S LECTURE NOTES
for the
SCHOOL OF THE MAN MADE FUTURE
1972/3

Pollution	Natural Resources
Food	Energy
Population	
Urbanisation	
Controlling the Nature of Man	
Health	
Wealth	
Work and Leisure	
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Volume ten
Number twelve
May 1974

University of Edinburgh BULLETIN

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by Professor C. H. WADDINGTON

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Evolution and Consciousness

HUMAN SYSTEMS IN TRANSITION

Edited by
Erich Jantsch and Conrad H. Waddington

containing no less than two academic holidays. This has certainly not made the organisation of teaching programmes any easier.

To my mind the best way of putting this business right would be for the University to take a four-week vacation at Christmas (like most other universities), thus putting the whole calendar backwards by one week. Surely we can afford to lop a week off the vastly long Summer vacation, and this change would provide a decent respite at Christmas, allow a more adequate period to prepare for the Spring Term, and also (presumably) reduce the University's heating bill! Anyone agree?

Adam Crowther

Department of Economics

Man-Made Future School's future

The impending closure of the School of the Man-Made Future has made many of us more aware of its value and purpose. I would like to make a few suggestions about how we might proceed from here.

There are a number of premises from which to build. Firstly, there are many individuals and organisations which share an active interest in the problems and future of man-kind; it is essential that a "school" inevitably composed of the like-minded converted should nevertheless include radically different points of view and approaches. There are thus probably limitations in the value of a school run essentially by one person. On the other hand, Professor Waddington showed what can be done: to make a success of the School of the Man-Made Future required some rare assets: it needed a man of vision with a wide background and with many international friends, in addition to the enthusiasm and willingness to devote a large proportion of time and energy to the venture. The advantages of the one-man show are many; the disadvantages are that it depends on the rare personality and that it tends to scatter the other related interests.

The small committee of the Centre of Human Ecology could draw on local talent to give a series of lectures and discussion groups and invite occasional visiting lecturers.

This would not require much extra finance, assuming that the Centre or something like it will continue beyond the one year which has just been agreed. The opportunity could be taken to bring together the various other interested groups. The problems that all such activities will encounter is a growing apathy; to keep up an interest one needs some periodic rebirth. Unless the committee is sensitive to the changing perception of the problems, it will be limited in its scope and in its life. I suggest that we start something better called a College, which would be a loose "umbrella" organisation to include other societies, groups or parts of Departments and provide a forum for study, lectures and research projects. This "umbrella" organisation would have a rotating chairman with a tenure of two or three years, during which time this job would be a major occupation. This system would have the advantages of the enthusiasm of a personal approach, a chairman would become identified with some particular aspect or approach; the short tenure means that there would be a wide choice of chairmen, not limited to those near retirement who are able to give up their other careers; the rotation would provide repeated opportunities for a rebirth or change in direction, yet the "College" would have the function of holding the threads together to give continuity and lead to some real progress. There should be a large overlap in tenure between chairmen so that planning can be started for a year ahead.

This organisation would have an important teaching function outside the departmental structure; I think that it should never give an undergraduate course in the usual sense, but rather interest students from all fields. One could consider the possibility that a part of all undergraduate training should include some exposure to the "problematic" and some of the existing lecture programmes might be included in the scheme.

I know that the struggle to find a suitable name for any such "centre" has been difficult; yet one more attempt is now needed to include the concepts of Centre or College, Man, Ecology, Future. I would like to see a phrase that also provides a

fitting memorial to Professor Waddington.

It just happens that it was I who started writing this note—I hope that I have expressed some of the views of the many people with whom I have discussed the "Future". I would like to hear the views of those who are against such a proposal, those who have other ideas and those who would like to take an active part in some way. Please send a note to me (preferably not by phone) or to Professor C. B. Wilson.

Ubrich Loening

Department of Zoology

Obituary

The *Bulletin* regrets to record the death of Professor Victor Nikitych Lazarev, Associate Member of the U.S.S.R. Academy of Sciences, who died in Moscow on January 31 at the age of 78. Professor Lazarev was awarded the Honorary Degree of LLB by this University in 1961 *in absentia*.

Son of a Moscow architect, Professor Lazarev was considered the greatest living expert in the art of Byzantium and Russia.

Of his many writings the most important are his *History of Byzantine Painting*, his *Art of Novgorod*, his great *History of Russian Art* and his *Origins of the Italian Renaissance*.

AGM of Association of Physicians

The seventieth Annual General Meeting of the Association of Physicians is being held in Edinburgh on April 2-3. This University's Professor of Medicine, Kenneth W. Donald, will be President.

The scientific programme includes a series of demonstrations illustrating recent work in medicine and allied specialities which has been carried out in University and Hospital departments in Edinburgh. Arrangements have been made for the exhibits to remain on display in the Faculty Rooms of the David Hume Tower from 9 a.m. to 5 p.m. on Monday, April 5. All interested are invited to attend.

SCIENCE AS A WAY OF KNOWING

An Ongoing Project of the
Education Committee
of the
American Society of Zoologists

Cosponsored by
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The Biological Sciences Curriculum Study
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The National Association of Biology Teachers
The Society for College Science Teachers
The Ecological Society of America
The Genetics Society of America
and the
University of California at Riverside

II

SCIENCE AS A WAY OF KNOWING— HUMAN ECOLOGY

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Human Ecology: The Subversive, Conservative Science¹

GARRETT HARDIN

Department of Biological Sciences, University of California,
Santa Barbara, California 93106

SYNOPSIS. Paul Sears identified ecology as a subversive science; William Ophuls, referring primarily to its human applications, called it a conservative science. Both characterizations are correct. Human ecologists aim to conserve natural resources, thereby making it possible for our posterity to enjoy a quality of life at least equal to ours. Frequently this kind of conservatism is at odds with the conservation of traditional religious beliefs, political practices, and social privileges: hence the aptness of the adjective "subversive." The essence of human ecology is found in a few propositions of the sort that mathematician E. T. Whittaker called "postulates of impotence." These lead to simple but profound generalizations, of which a dozen are offered here.

Identifying a single science as both "subversive" and "conservative" may seem a perverse thing to do, but I will explain the combination before I am through. To begin with let us see how the first adjective came to be applied to ecology. Paul Sears (1964), just two years after the publication of Rachel Carson's *Silent Spring*, asked:

Is ecology a phase of science of limited interest and utility? Or, if taken seriously as an instrument for the long-run welfare of mankind, would it endanger the assumptions and practices accepted by modern societies, whatever their doctrinal commitments?

In the discussion that followed Sears made it quite clear that he regarded ecology as being of almost unlimited interest and utility for everyday life, acknowledging that its principles threatened many assumptions and practices in the existing social order. Sears, far from a radical in ordinary political matters, was forced to conclude that ecology is a subversive science.

A short time later Paul Shepard and Dan McKinley (1969) borrowed Sears' words for the title of a useful anthology. Before a decade had passed, William Ophuls (1973), in a remarkable dissertation offered in support of a Ph.D. degree in political science, identified the subversive threat more

Human ecology is against the conquest of nature; against growth as we think of it; against the isolation of thought and action; against individualism as an ideology; and against moral absolutes like the inalienable rights of man. "The subversive science" is thus a pitifully weak soubriquet for ecology, which demands only that our current political, social, economic, and moral order be stood on its head.

When the human ecologist fully understands the irony of Ophuls' concluding words he realizes how lonely is the path he must walk as he is belabored by both Left and Right of the political spectrum. I would not have the ecologist turn aside because of a justifiable fear of vested powers; rather would I urge that he make use of the resources of humor, stiffening his backbone by recalling a comment made by the professional humorist Art Hoppe (1970), who caused an imaginary happy-go-lucky student radical to say: "The great thing about ecology as a cause is that everybody's guilty."

Yet another burden falls on human ecologists: the science is inescapably interdisciplinary. To quote once more from Sears (1971): "It may clear matters somewhat to modify the usual definition of ecology as the science of interrelation between life and environment. Actually, it is a way of approaching this vast field of experience

ENVISIONING THE FUTURE

*TUESDAYS, at 6.30pm (except the first: Wednesday 3rd February)
in the David Hume Tower, Faculty Room North.*

3rd February (WEDNESDAY): (4)
CHOOSING LIFE FOR OURSELVES AND THE PLANET:

Theology, gender, and environment

ELIZABETH DOBSON GRAY,

Bolton Institute for a Sustainable Future, Mass. USA

9th February: (5)

IRRATIONALITY AND ENVIRONMENTAL POLICY

Prof ANDREW BRENNAN, Dept of Philosophy,
The University of Western Australia, Perth.

16th February: (6)

WHO ENVIRONS WHAT?

Reflections on beliefs about world ecosystems.

PHILIP STEWART, Pauling Human Sciences Centre, University of Oxford.

23rd February: (7)

FOLLOW-UP TO THE EARTH SUMMIT:

international programmes towards sustainability

STANLEY JOHNSON, formerly DG XI, Environment, EC; now Director,
International and Policy Services, Environmental Resources Ltd, Oxford.

2nd March: (8)

LOOKING TO 2010: AGENDA FOR A SUSTAINABLE SCOTLAND

MICHAEL CARLEY, Centre for Human Ecology, University of Edinburgh

9th March: (9)

PROSPECTS FOR SOCIO-ECONOMIC REFORM IN RUSSIA

Prof VLADIMIR KOLLONTAI, Senior Research Fellow, Institute of World
Economics and International Affairs, Russian Academy of Sciences, Moscow

16th March: (10)

MOBILISING GREEN CONSCIOUSNESS:

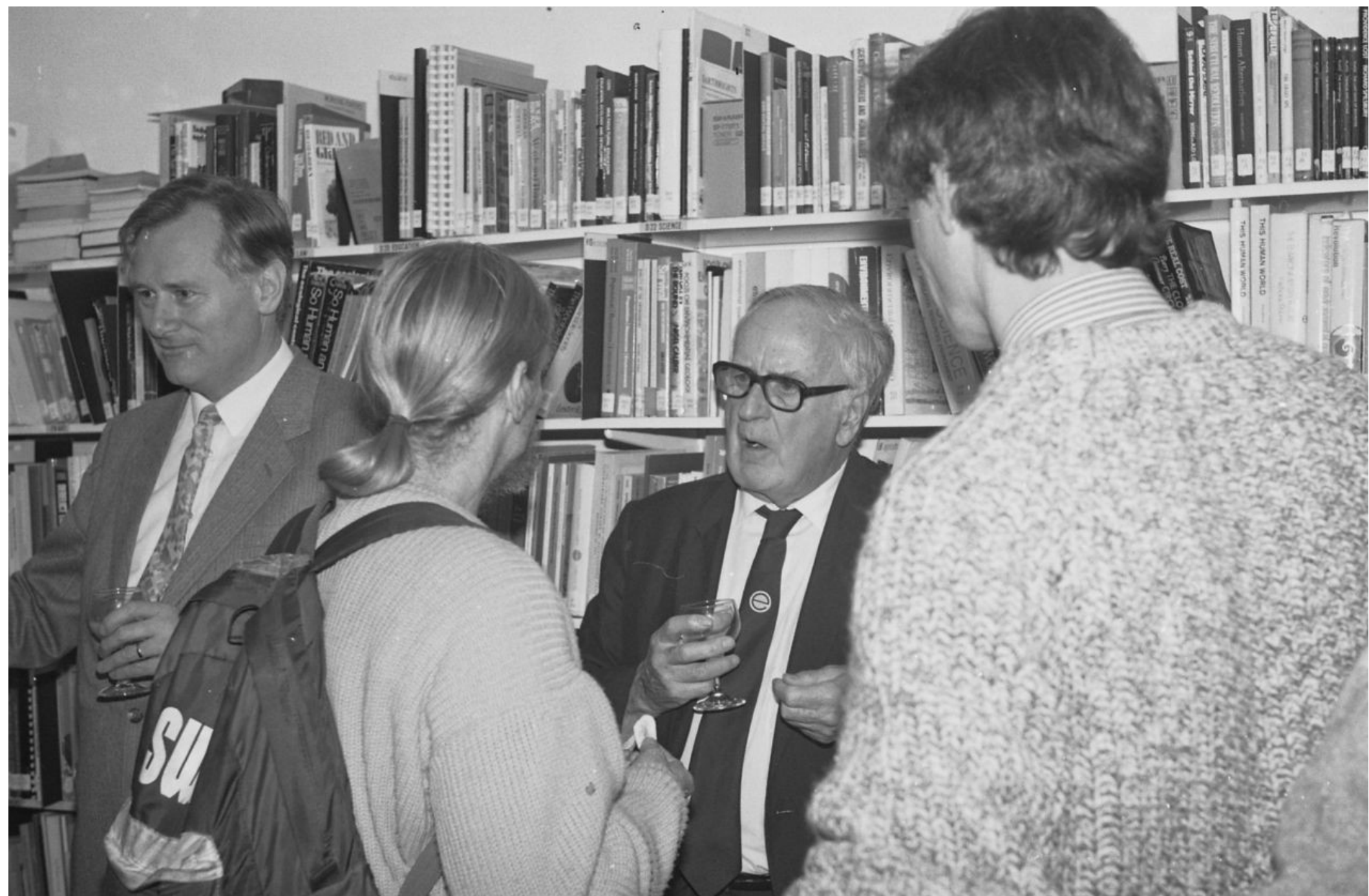
The role of SNH in the Highlands and Islands

Sir JOHN LISTER-KAYE, Chairman, Scottish Natural Heritage, NW.

23rd March: (11)

HOW TO MAKE A NEW ECONOMICS RELEVANT

JAMES ROBERTSON, author of "FUTURE WEALTH, a New Economics for the
21st Century"; Turning Point 2000, Oxfordshire.









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DR NART TUNTAWIROON: Thailand's leading Anti-Dam Campaigner

The recent murder of the Dean of a University in Bangkok did not make world news, but, in Thailand, Dr Nart Tuntawiroon was no obscure academic—he was a fierce fighter against destruction of the natural environment by dam builders and had managed to stave off construction of a major dam on the Mae Klong River—the River Kwai of world fame.

There is no evidence to connect the murder of Dr Tuntawiroon and his wife in his office at Mahidol University on 20 November 1984 with the dam controversy, but his passing is a great blow to the conservation movement.

Dr Tuntawiroon had only just returned home from attending the General Assembly of the International Union for Conservation of Nature and Natural Resources (IUCN) in Madrid. Leading world scientists and conservationists were impressed by his cogent indictment of his country's dam building programme. This indictment, which has world-wide relevance, is Dr Tuntawiroon's testament as it appears in a contribution to a book which is being published by *The Ecologist*. In it he recounts his detailed criticisms of the Nam Choean dam project on the Mae Klong in Kanchanaburi Province at a special Cabinet meeting in 1982, which resulted in postponing a decision on proceeding with the dam.

Dr Tuntawiroon accused the Electricity Generating Authority of Thailand (EGAT) of "major errors" in its report to the Cabinet. Rainfall data could be 400% wrong and the amount of potential energy exaggerated. He added that no account was taken of opportunity, social and environmental costs of impounding large areas of land and forest, loss of land fertility downstream and loss of marine productivity in the Gulf of



Dr Nart Tuntawiroon

Thailand because of reduced nutrient flow, which would be borne by the whole country, of potential loss of archaeological and anthropological wealth, as well as mineral resources. Indicated by recent exploration, of damage to the forest and wildlife of the Tung Yai and Huai Kha Khaeng wildlife sanctuaries—the largest contiguous block of forest land set aside for wildlife conservation in Thailand, and of siting the dam in an earthquake prone area.

Dr Tuntawiroon was able to convince the Cabinet to postpone approval of the Nam Choean dam for an initial 90 days, and today, just over two years later, a decision is still pending.

His standing as an opponent of the Nam Choean dam and other dam projects was strongly reinforced by

the fact that he was an electrical engineer, and initially a supporter of damming Thailand's rivers to produce energy, control floods and irrigate agricultural land. He was disillusioned. The frequency and magnitude of floods appeared to increase after dams were built, and to the authorities' claim that the floods would have been even worse and more dams were needed he replied: "We might as well build a roof to cover the total area of Thailand."

Dr Tuntawiroon drew pointed attention to the failure of the dams to produce the steady flow of hydro-electricity predicted. In 1966, when there were two dams, hydro-energy accounted for 64 per cent of electricity generated, but in 1980, when there were 10 dams, it accounted for only 8.4 per cent. Instead of providing the basic source of electricity, the projects were only intermittently supplying peak load.

He declared that multi-purpose dams in the tropics were not buffers against weather fluctuation, but were at the mercy of the weather. On 3 November 1984 the *Bangkok Post* frontpaged reports of severe floods in many parts of Thailand alongside a report about critically low levels in the power dams. To the layman there might appear to be large amounts of impounded water, but it was "dead storage" because it was below the power intake level.

Hydro authorities, Dr Tuntawiroon said, were "very possessive" of the "dead storage" because of the time it takes to accumulate and they release water for irrigation only from "live storage", which fluctuates widely both in a year and over the years. The result is that farmers fail to get irrigation water when they need it, and, ironically, it is released when they are enjoying natural supplies.

"A hydro-electric power dam is

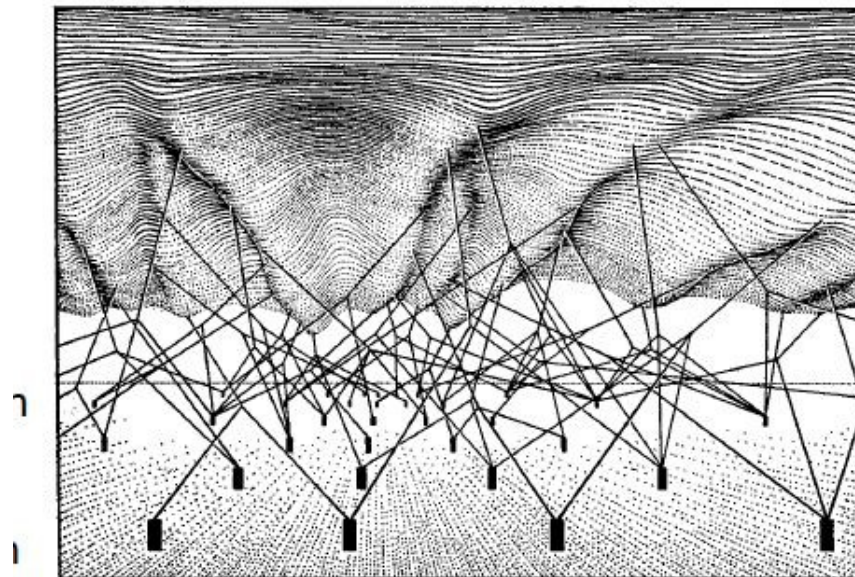
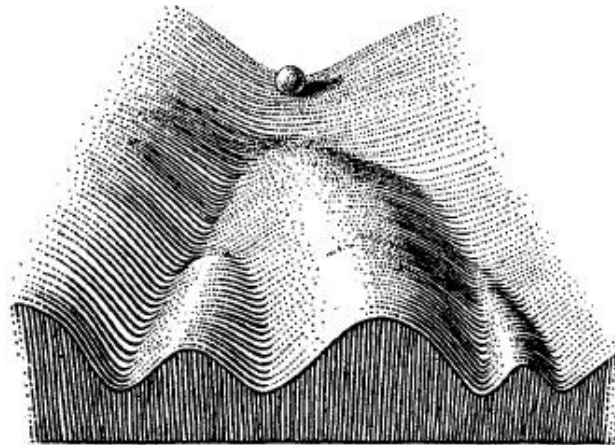








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Jablonka & Lamb, 2006; ilustrações de Anna Zeligowski.

Criteria for a convivial science/technology

	CONVIVIAL SCIENCE	CONVENTIONAL INDUSTRIAL SCIENCE
1.	Driven by solar energy	Driven mainly by stored fuel, fossil or biomass
2.	Works in cycles	Works linearly
3.	All materials are recycled, there is no waste	Resources are consumed to waste
4.	Competition and Co-operation in ecosystems	Conquest by over-riding natural systems
5.	No great excesses	Large excesses
6.	Increases biological diversity	Decreases diversity
7.	Global stability	Global changes
8.	Multiple feed-back controls, mostly negative	Little feed-back control, mostly positive



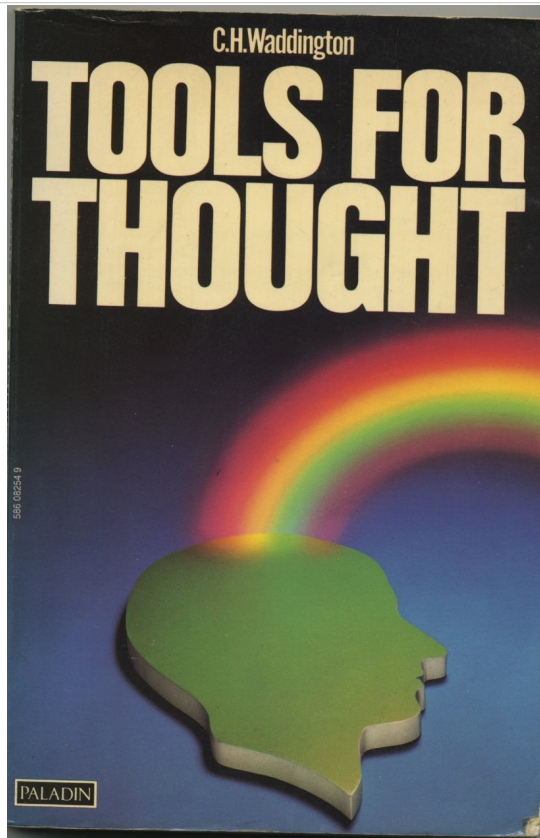
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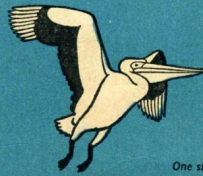


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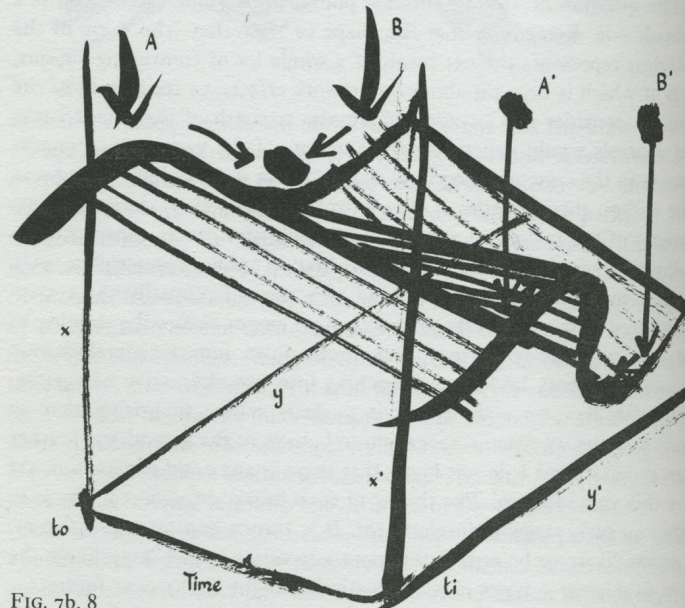


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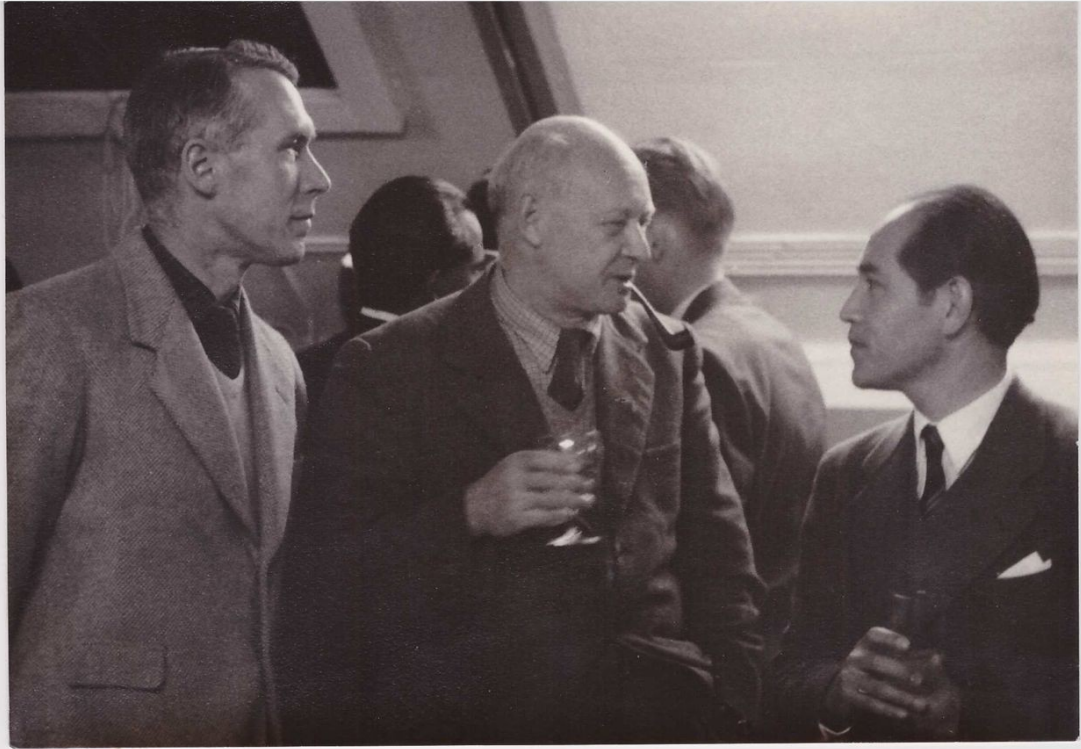
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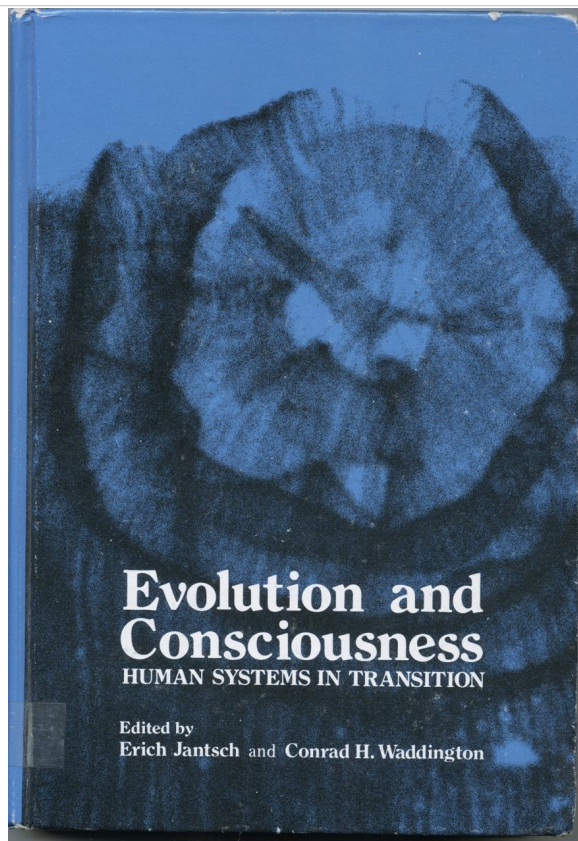
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containing no less than two academic holidays. This has certainly not made the organisation of teaching programmes any easier.

To my mind the best way of putting this business right would be for the University to take a four-week vacation at Christmas (like most other universities), thus putting the whole calendar backwards by one week. Surely we can afford to top a week off the vastly long Summer vacation, and this change would provide a decent respite at Christmas, allow a more adequate period to prepare for the Spring Term, and also (presumably) reduce the University's heating bill! Anyone agree?

Adam Crowther
Department of Economics

Man-Made Future School's future

The impending closure of the School of the Man-Made Future has made many of us more aware of its value and purpose. I would like to make a few suggestions about how we might proceed from here.

There are a number of premises from which to build. Firstly, there are many individuals and organisations which share an active interest in the problems and future of mankind; it is essential that a "school" inevitably composed of the like-minded converted should nevertheless include radically different points of view and approaches. There are thus probably limitations in the value of a school run essentially by one person. On the other hand, Professor Waddington showed what can be done: to make a success of the School of the Man-Made Future required some rare assets: it needed a man of vision with a wide background and with many international friends, in addition to the enthusiasm and willingness to devote a large proportion of time and energy to the venture. The advantages of the one-man show are many; the disadvantages are that it depends on the rare personality and that it tends to scatter the other related interests.

The small committee of the Centre of Human Ecology could draw on local talent to give a series of lectures and discussion groups and invite occasional visiting lecturers.

This would not require much extra finance, assuming that the Centre or something like it will continue beyond the one year which has just been agreed. The opportunity could be taken to bring together the various other interested groups. The problems that all such activities will encounter is a growing apathy; to keep up an interest one needs some periodic rebirth. Unless the committee is sensitive to the changing perception of the problems, it will be limited in its scope and in its life. I suggest that we start something better called a College, which would be a loose "umbrella" organisation to include other societies, groups or parts of Departments and provide a forum for study, lectures and research projects. This "umbrella" organisation would have a rotating chairman with a tenure of two or three years, during which time this job would be a major occupation. This system would have the advantages of the enthusiasm of a personal approach, a chairman would become identified with some particular aspect or approach; the short tenure means that there would be a wide choice of chairmen, not limited to those near retirement who are able to give up their other careers; the rotation would provide repeated opportunities for a rebirth or change in direction, yet the "College" would have the function of holding the threads together to give continuity and lead to some real progress. There should be a large overlap in tenure between chairmen so that planning can be started for a year ahead.

This organisation would have an important teaching function outside the departmental structure; I think that it should never give an undergraduate course in the usual sense, but rather interest students from all fields. One could consider the possibility that a part of all undergraduate training should include some exposure to the "problematic" and some of the existing lecture programmes might be included in the scheme.

I know that the struggle to find a suitable name for any such "centre" has been difficult; yet one more attempt is now needed to include the concepts of Centre or College, Man, Ecology, Future. I would like to see a phrase that also provides a

fitting memorial to Professor Waddington.

It just happens that it was I who started writing this note—I hope that I have expressed some of the views of the many people with whom I have discussed the "Future". I would like to hear the views of those who are against such a proposal, those who have other ideas and those who would like to take an active part in some way. Please send a note to me (preferably not by phone) or to Professor C. B. Wilson.

Ubrich Loening
Department of Zoology

Obituary

The *Bulletin* regrets to record the death of Professor Victor Nikitych Lazarev, Associate Member of the U.S.S.R. Academy of Sciences, who died in Moscow on January 31 at the age of 78. Professor Lazarev was awarded the Honorary Degree of LLB by this University in 1961 *in absentia*.

Son of a Moscow architect, Professor Lazarev was considered the greatest living expert in the art of Byzantium and Russia.

Of his many writings the most important are his *History of Byzantine Painting*, his *Art of Novgorod*, his great *History of Russian Art* and his *Origins of the Italian Renaissance*.

AGM of Association of Physicians

The seventieth Annual General Meeting of the Association of Physicians is being held in Edinburgh on April 2-3. This University's Professor of Medicine, Kenneth W. Donald, will be President.

The scientific programme includes a series of demonstrations illustrating recent work in medicine and allied specialties which has been carried out in University and Hospital departments in Edinburgh. Arrangements have been made for the exhibits to remain on display in the Faculty Rooms of the David Hume Tower from 9 a.m. to 5 p.m. on Monday, April 5. All interested are invited to attend.

SCIENCE AS A WAY OF KNOWING

An Ongoing Project of the
Education Committee
of the
American Society of Zoologists

Cosponsored by

The American Society of Naturalists
The Society for the Study of Evolution
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The Association for Biology Laboratory Education
The National Association of Biology Teachers
The Society for College Science Teachers
The Ecological Society of America
The Genetics Society of America
and the
University of California at Riverside

II

SCIENCE AS A WAY OF KNOWING— HUMAN ECOLOGY

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Human Ecology: The Subversive, Conservative Science¹

GARRETT HARDIN

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SYNOPSIS. Paul Sears identified ecology as a subversive science; William Ophuls, referring primarily to its human applications, called it a conservative science. Both characterizations are correct. Human ecologists aim to conserve natural resources, thereby making it possible for our posterity to enjoy a quality of life at least equal to ours. Frequently this kind of conservatism is at odds with the conservation of traditional religious beliefs, political practices, and social privileges: hence the aptness of the adjective "subversive." The essence of human ecology is found in a few propositions of the sort that mathematician E. T. Whittaker called "postulates of impotence." These lead to simple but profound generalizations, of which a dozen are offered here.

Identifying a single science as both "subversive" and "conservative" may seem a perverse thing to do, but I will explain the combination before I am through. To begin with let us see how the first adjective came to be applied to ecology. Paul Sears (1964), just two years after the publication of Rachel Carson's *Silent Spring*, asked:

Is ecology a phase of science of limited interest and utility? Or, if taken seriously as an instrument for the long-run welfare of mankind, would it endanger the assumptions and practices accepted by modern societies, whatever their doctrinal commitments?

In the discussion that followed Sears made it quite clear that he regarded ecology as being of almost unlimited interest and utility for everyday life, acknowledging that its principles threatened many assumptions and practices in the existing social order. Sears, far from a radical in ordinary political matters, was forced to conclude that ecology is a subversive science.

A short time later Paul Shepard and Dan McKinley (1969) borrowed Sears' words for the title of a useful anthology. Before a decade had passed, William Ophuls (1973), in a remarkable dissertation offered in support of a Ph.D. degree in political science, identified the subversive threat more

Human ecology is against the conquest of nature; against growth as we think of it; against the isolation of thought and action; against individualism as an ideology; and against moral absolutes like the inalienable rights of man. "The subversive science" is thus a pitifully weak soubriquet for ecology, which demands only that our current political, social, economic, and moral order be stood on its head.

When the human ecologist fully understands the irony of Ophuls' concluding words he realizes how lonely is the path he must walk as he is belabored by both Left and Right of the political spectrum. I would not have the ecologist turn aside because of a justifiable fear of vested powers; rather would I urge that he make use of the resources of humor, stiffening his backbone by recalling a comment made by the professional humorist Art Hoppe (1970), who caused an imaginary happy-go-lucky student radical to say: "The great thing about ecology as a cause is that everybody's guilty."

Yet another burden falls on human ecologists: the science is inescapably interdisciplinary. To quote once more from Sears (1971): "It may clear matters somewhat to modify the usual definition of ecology as the science of interrelation between life and environment. Actually, it is a way of approaching this vast field of experience

ENVISIONING THE FUTURE

TUESDAYS, at 6.30pm (except the first: Wednesday 3rd February)
in the David Hume Tower, Faculty Room North.

3rd February (WEDNESDAY): (4)
CHOOSING LIFE FOR OURSELVES AND THE PLANET:
Theology, gender, and environment
ELIZABETH DOBSON GRAY,
Bolton Institute for a Sustainable Future, Mass. USA

9th February: (5)
IRRATIONALITY AND ENVIRONMENTAL POLICY
Prof ANDREW BRENNAN, Dept of Philosophy,
The University of Western Australia, Perth.

16th February: (6)
WHO ENVIRONS WHAT?
Reflections on beliefs about world ecosystems.
PHILIP STEWART, Pauling Human Sciences Centre, University of Oxford.

23rd February: (7)
FOLLOW-UP TO THE EARTH SUMMIT:
international programmes towards sustainability
STANLEY JOHNSON, formerly DG XI, Environment, EC; now Director,
International and Policy Services, Environmental Resources Ltd, Oxford.

2nd March: (8)
LOOKING TO 2010: AGENDA FOR A SUSTAINABLE SCOTLAND
MICHAEL CARLEY, Centre for Human Ecology, University of Edinburgh

9th March: (9)
PROSPECTS FOR SOCIO-ECONOMIC REFORM IN RUSSIA
Prof VLADIMIR KOLLONTAI, Senior Research Fellow, Institute of World
Economics and International Affairs, Russian Academy of Sciences, Moscow

16th March: (10)
MOBILISING GREEN CONSCIOUSNESS:
The role of SNH in the Highlands and Islands SOUTH
Sir JOHN LISTER-KAYE, Chairman, Scottish Natural Heritage, NW.

23rd March: (11)
HOW TO MAKE A NEW ECONOMICS RELEVANT
JAMES ROBERTSON, author of "FUTURE WEALTH, a New Economics for the
21st Century"; Turning Point 2000, Oxfordshire.





























DR NART TUNTAWIROON: Thailand's leading Anti-Dam Campaigner

The recent murder of the Dean of a University in Bangkok did not make world news, but, in Thailand, Dr Nart Tuntawiroon was no obscure academic—he was a fierce fighter against destruction of the natural environment by dam builders and had managed to stave off construction of a major dam on the Mae Klong River—the River Kwai of world fame.

There is no evidence to connect the murder of Dr Tuntawiroon and his wife in his office at Mahidol University on 20 November 1984 with the dam controversy, but his passing is a great blow to the conservation movement.

Dr Tuntawiroon had only just returned home from attending the General Assembly of the International Union for Conservation of Nature and Natural Resources (IUCN) in Madrid. Leading world scientists and conservationists were impressed by his cogent indictment of his country's dam building programme. This indictment, which has world-wide relevance, is Dr Tuntawiroon's testament as it appears in a contribution to a book which is being published by *The Ecologist*. In it he recounts his detailed criticisms of the Nam Choan dam project on the Mae Klong in Kanchanaburi Province at a special Cabinet meeting in 1982, which resulted in postponing a decision on proceeding with the dam.

Dr Tuntawiroon accused the Electricity Generating Authority of Thailand (EGAT) of "major errors" in its report to the Cabinet. Rainfall data could be 400% wrong and the amount of potential energy exaggerated. He added that no account was taken of opportunity, social and environmental costs of impounding large areas of land and forest, loss of land fertility downstream and loss of marine productivity in the Gulf of



Dr Nart Tuntawiroon

Thailand because of reduced nutrient flow, which would be borne by the whole country, of potential loss of archaeological and anthropological wealth, as well as mineral resources, indicated by recent exploration, of damage to the forest and wildlife of the Tung Yai and Huai Kha Khaeng wildlife sanctuaries—the largest contiguous block of forest land set aside for wildlife conservation in Thailand, and of siting the dam in an earthquake prone area.

Dr Tuntawiroon was able to convince the Cabinet to postpone approval of the Nam Choan dam for an initial 90 days, and today, just over two years later, a decision is still pending.

His standing as an opponent of the Nam Choan dam and other dam projects was strongly reinforced by

the fact that he was an electrical engineer, and initially a supporter of damming Thailand's rivers to produce energy, control floods and irrigate agricultural land. He was disillusioned. The frequency and magnitude of floods appeared to increase after dams were built, and to the authorities' claim that the floods would have been even worse and more dams were needed he replied: "We might as well build a roof to cover the total area of Thailand."

Dr Tuntawiroon drew pointed attention to the failure of the dams to produce the steady flow of hydro-electricity predicted. In 1966, when there were two dams, hydro-energy accounted for 64 per cent of electricity generated, but in 1980, when there were 10 dams, it accounted for only 8.4 per cent. Instead of providing the basic source of electricity, the projects were only intermittently supplying peak load.

He declared that multi-purpose dams in the tropics were not buffers against weather fluctuation, but were at the mercy of the weather. On 3 November 1984 the *Bangkok Post* frontpaged reports of severe floods in many parts of Thailand alongside a report about critically low levels in the power dams. To the layman there might appear to be large amounts of impounded water, but it was "dead storage" because it was below the power intake level.

Hydro authorities, Dr Tuntawiroon said, were "very possessive" of the "dead storage" because of the time it takes to accumulate and they release water for irrigation only from "live storage", which fluctuates widely both in a year and over the years. The result is that farmers fail to get irrigation water when they need it, and, ironically, it is released when they are enjoying natural supplies.

"A hydro-electric power dam is

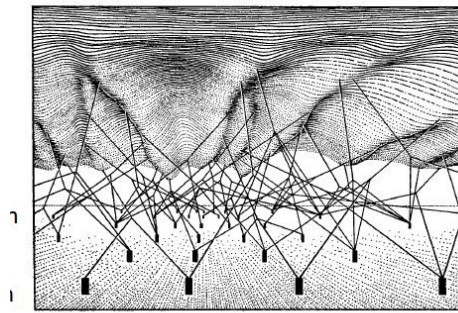
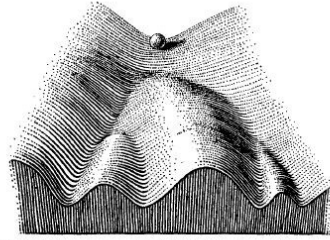








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Jablonka & Lamb, 2006; ilustrações de Anna Zeligowski.

Criteria for a convivial science/technology

	CONVIVIAL SCIENCE	CONVENTIONAL INDUSTRIAL SCIENCE
1.	Driven by solar energy	Driven mainly by stored fuel, fossil or biomass
2.	Works in cycles	Works linearly
3.	All materials are recycled, there is no waste	Resources are consumed to waste
4.	Competition and Co-operation in ecosystems	Conquest by over-riding natural systems
5.	No great excesses	Large excesses
6.	Increases biological diversity	Decreases diversity
7.	Global stability	Global changes
8.	Multiple feed-back controls, mostly negative	Little feed-back control, mostly positive